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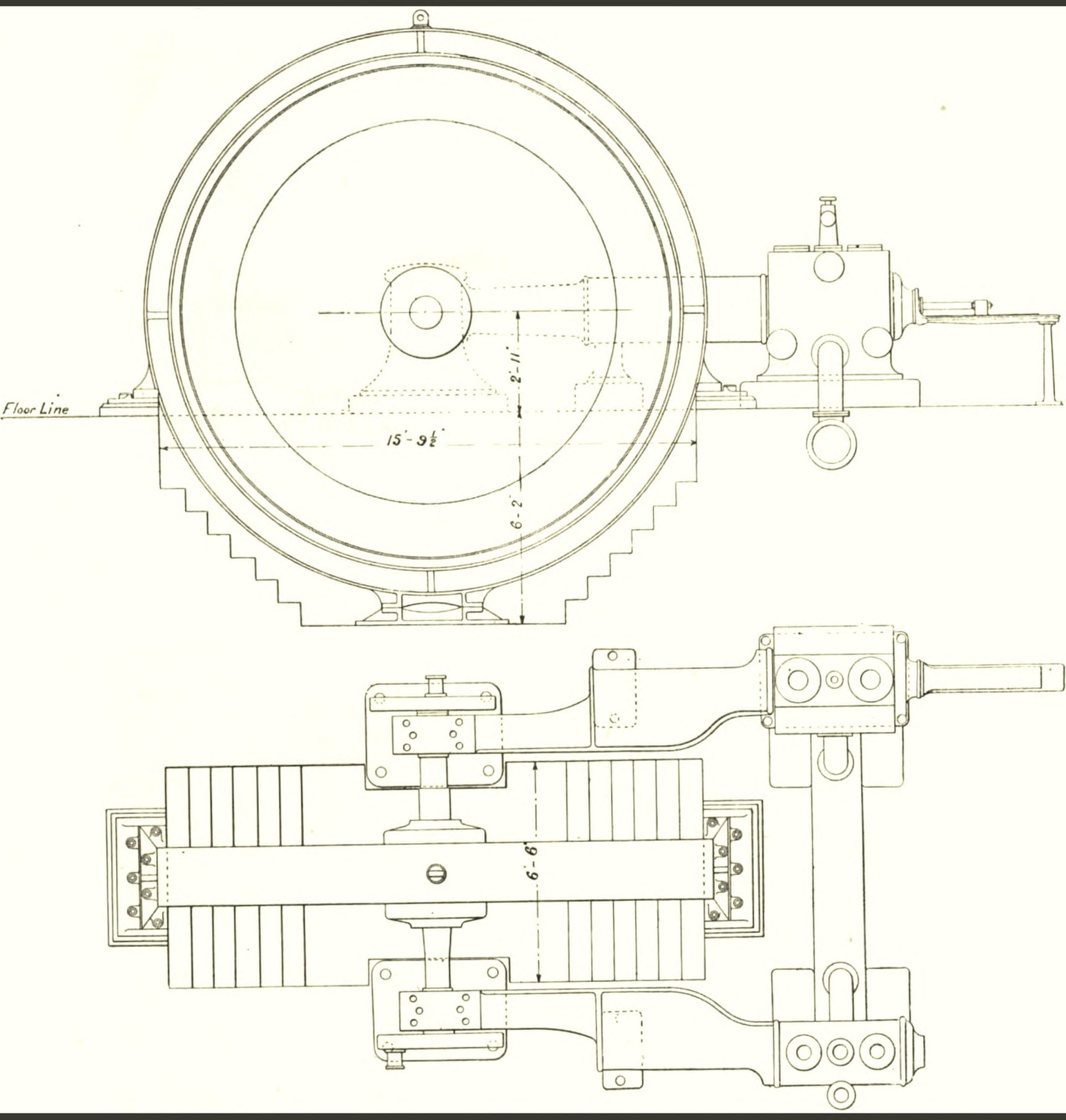

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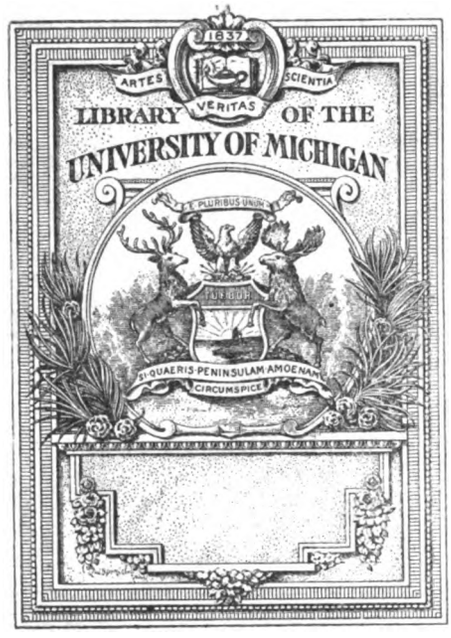

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THE

ELECTRICAL ENGINEER.

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NOTES.

Back to Electricity.—The Avenue de l'Opéra in Paris is to be again lighted by electricity instead of gas. In the early days of electric lighting the Jablochkoff candle was used for a time in the Avenue.

A New Year's Dinner.—On New Year's Eve a dinner was given by Mr. Robt. W. Paul, of 44, Hatton-garden, to all his employés. The dinner took place at the Holborn Restaurant, and a very pleasant evening was spent.

C.M.G.—In the list of the New Year honours occurs the name of Mr. Henry Charles Fischer, controller of the Central Telegraph Department of the General Post Office, who is made a Companion of the Order of St. Michael and St. George.

A New Use for Electric Tramways.—According to the *Street Railway Journal*, the Sioux City Electric Tramway Company have been running a car which carries no passengers, but is exclusively devoted to the display of advertisements.

The Electrical Standardising, Testing, and Training Institution.—Mr. James Swinburne will commence his usual course of lectures on "Dynamo and Transformer Construction" at this institution, Charing Cross-road, on Thursday, January 9.

Electricity in Dentistry.—Dr. M. G. Jenison, of Minneapolis, reports that electricity has been successfully employed by him in checking hemorrhage from the extraction of teeth. The current, he states, caused instant coagulation of the blood and gave relief where the usual remedies were without effect.

Electricity at Christmas.—It is noted that the Christmas tree at the University College Hospital, Gower-street, was this year illuminated by a number of little Edison-Swan lamps. There may not be quite so much sentiment about the electric light as with the time-honoured candle, but it is certainly much less dangerous.

Telegraphs in Turkey.—The authorities of Aleppo have petitioned the Central Government to lay a telegraphic line between Marash and Enderin. Several localities situated on the Turko-Persian frontier, in the district of Suleimanieh, are about to be connected by telegraph lines with each other and with the network of the empire.

High-Voltage Tramway Lines.—With the increase in the length of tramway systems in America comes the desire to raise the pressure above 500 volts. The *Street Railway Review*, in advocating this, says that, in view of past experience, it is not unreasonable to consider that 1,000 volts direct current might be used with safety on long trolley lines.

Aluminium.—It is stated that the Pittsburg Reduction Company are about to increase their producing capacity at Niagara Falls to a very important extent. A contract has just been concluded with the Cataract Construction Company whereby the Pittsburg Company's new plant, established at the Falls last year, will be doubled in capacity, making it the largest aluminium works in the world.

The Nile as a Motive Power.—According to the *Politischen Maschinen Constructeur*, the problem of using the Nile as a source of energy is being seriously considered in Egypt. If a reservoir is constructed at Assouan a fall of 15 metres (49ft.) would be available, and another fall of 5 metres (16½ft.) could be utilised in the neighbourhood of Cairo. The proposal is to set up at these places electric power distributing plant which would serve a series of cotton mills.

Indian Government Telephones.—The *Indian and Eastern Engineer* says that a much improved system of telephone apparatus will shortly be introduced into some of the Indian Government offices. The apparatus is of the type first exhibited at the late Chicago Exhibition, which does away with the necessity of ringing the bell to signify one's intention of making a communication. In the new apparatus it is claimed that it is only necessary to speak and the communication will be heard for a good space around the instrument at the other end.

The Turin Exhibition of 1898.—From *L'Elettricità* it appears that the committee entrusted with the organisation of the electrical section of the Turin Exhibition of 1898 has passed a resolution to the effect that as the electric industry in Italy has nothing to fear from comparison with foreign work, and, moreover, since being of scientific as well as manufacturing and mechanical interest, the province of an electrical exhibition is world-wide, the committee have determined that the electrical section of the exhibition should be open to all nations.

Telegraphs in Central Africa and China.—The telegraph line is now completed from Cape Town to Blantyre, and before Major Forbes leaves the Chartered Company's northern territory it will be laid to Tanganyika. Dr. Robert Laws has trained Atonga converts to become skilled signallers at Karonga, Koudowi, and Bandawe. On the Asiatic side, the direct route to China overland, through Mora and Burma, by Bhamo, is in working order, and it is reported from Calcutta that the traffic is steadily increasing, and that the route only needs to be tried more largely to lead the Chinamen signallers to do still better.

Trolley Patents in the States.—Judge Townsend, of the United States Circuit Court, has sustained the fundamental patent of Van Depoele on the trolley, and declared void a subsidiary patent applying to the rotating support on which the trolley arm swings. The decision will be appealed against, but the *Electric Railway Gazette* thinks that in the meantime its effect will be to direct greater attention to underground electric traction systems in the United States. If the decision is sustained, it practically gives the General Electric Company the right to manufacture and sell the under-running trolley as it is used on most American tramroads.

Genoa Tramways.—A paragraph has been going round the papers to the effect that the electric tramways in

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Genoa had been stopped by the police authorities on account of danger to the public. The truth of the matter appears to be that there is in Genoa a very steep and long street, called the Via Assarotti, with a gradient of 7½ per cent., and on the tramline in this street two cars overran their brakes and killed a horse, upon which the authorities stopped temporarily the running on this line only. It is further stated that, so far from the tramways being unsatisfactory, it is intended to extend the system during the coming year right out to the suburb of San Francisco d'Albano.

Liverpool Engineering Society.—At the meeting of this society on January 8 a paper will be read by Mr. J. R. Fothergill, M.Inst.N.A., M.Inst.Mech.E., on "Combustion in Marine Boilers," and the president will present the West Premium to Mr. Wm. Rowland, Whit.Sch., for his paper entitled "Recent Improvements in Locomotive Design." The president will also announce that the Right Hon. the Earl of Derby, G.C.B., and Mr. W. H. Preece, M.I.C.E., C.B., F.R.S., vice-president of the Institution of Civil Engineers, have, upon the invitation of the council, agreed to become honorary members of the society. The annual dinner of the society will take place at the Adelphi Hotel, Liverpool, on January 29, 1896.

The Madras Electric Tramways.—Mr. F. R. Upcot, consulting engineer for railways, has officially inspected the section of the line recently completed between the Napier water pandal and Barber's bridge *vid* Chintadripettah and Triplicane. Mr. Upcot was accompanied by his deputy (Mr. Fowler), Mr. O'Shaughnessy, chief engineer, M.E.T., Mr. Gadsby, electrician and superintending engineer, Mr. Winter, electrical engineer, M.R.C., Mr. Salisbury, assistant secretary, and Mr. Whitmore Clarke. The trip on the car worked by the overhead system was not quite successful, there being some hitch owing to heavy rain and to an inadvertent omission in the equipment of the car, which is easily remediable. The consulting engineer declared the line fit for traffic.

Electric Elevator.—A unique electric elevator has been built for the Ottawa Canoe Club, Ottawa, Ont. The Ottawa River being subject to a great rise every spring, the boathouse, necessarily, is situated during the greater part of the year at a considerable elevation above water level. In order to minimise the difficulty hitherto experienced in transferring boats from the house to the water, or *vice versâ*, there has been erected a framed gangway, with skeleton car, elevated by means of an ordinary worm-geared hoisting drum. The motive power is obtained from a three-kilowatt 500-volt Edison motor. The motor is belted to a countershaft, which, in turn, is belted to the shaft carrying the worm, and the car is stopped automatically at the termination of its course either way.

Spain.—Steady progress, says *Industries and Iron*, continues to be made with the adoption of electric lighting in Spain. It has been decided to increase the capacity of the plant at the central station at Tolosa. A 60 years' concession has lately been granted for the establishment and the operation of a central station at Vera, a small town in the province of Almeria. Two new 45-h.p. steam dynamos are being added to the central station at Torrelavego (Santander province). Work is at present in hand on the establishment of a central station at Burriana in Castellon province. The plant, which is being supplied by Messrs. Levi and Kocherthaler, who are the Spanish agents of the Allgemeine Elektrictäts-Gesellschaft of Berlin, comprises a 100-h.p. steam-engine and a continuous-current dynamo. The distribution is on the overhead three-wire system.

The Telephone Monopoly.—The *City Press* says that the Telephone Company is always getting into hot water. One day it is the charge that gives rise to indignation on the part of subscribers. Another day the difficulty of getting attended to, and when attended to of being able to obtain connection is insisted upon. Now we have a would-be subscriber instancing the delay there is in inducing the company to place him on the telephone. He has been waiting, it seems, for six months, and still, to all appearances, he is no nearer being supplied that he was when the application was made. The delay there is in remedying the first-named shortcomings is understandable, but certainly it surpasses comprehension to realise the object the company has in being so blind to its own interests as to disregard orders to provide a receiver and the necessary connection. The rush of orders cannot be so great as to prevent each being attended to the moment it is received.

Electric Tanning.—Some interesting work on the subject of electric tanning is reported in the *Zeitschrift für Elektrochemie* by Herr Folsing. The writer states that he has worked out an electrical method of tanning, which he considers is suitable for both thin skins and heavy hides, and only requires from three to six days. The tanning pit contains 15,000 litres. Electrodes of nickelled copper are fixed to the walls of the pit, in which the hides are hung so that the current has to pass right through them. A current of 12 amperes with an E.M.F. of 12 volts is used. The colour of the leather is not quite satisfactory when commercial unpurified extract is used. The author lays stress on this, and he himself used an oak extract (with a little hemlock extract added) which is cleared and decolourised by a special electrolytic process. When this is used he finds that the colour is exceedingly good and bright. Light cowhides were found to require 72 hours, heavy cowhides five days, and heavy oxhides six days. The latter would require about a year by the old process.

The Kane-Pennington Motor.—The *Canadian Engineer* says that readers will be interested in knowing that the Mr. Pennington whose new motor it describes is the some gentleman who has been experimenting on machinery for navigating the air. "Though the application of the Kane-Pennington motor has been on machines travelling on land, the extraordinary power developed by the invention may actually lead to the accomplishment of what Mr. Pennington and so many other inventors have been vainly striving at—aerial navigation. The achievement will probably be as great a surprise to Mr. Pennington as to the rest of the world, but from tests reported in the *American Machinist* it really seems that the highest accomplishment of mechanical genius will soon be the gift of mankind. The principle of this new motor is so far a secret, and mechanical men, of all others with whom the writer has discussed the matter, have been most sceptical. Yet the tests made and the details given upon so good an authority, leave little doubt that the new motor is all that is claimed for it."

The Chicago Motocycle Race.—The American papers contain descriptions of Messrs. Morris and Salom's electric carriages which took the gold medal in the Chicago motocycle race. The largest of these appears to be built somewhat on the lines of what is called in America a "Surrey." The front wheels are the larger, and are driven by two Lundell motors of 1½ nominal horse-power capacity, each attached to the front axle and pinioned on the armature shafts, gearing directly into the driving gears attached to the wheels. The steering is done with the hind wheels. The energy is derived from batteries furnished by the Electric Storage Battery Company, of Philadelphia, and consist of four sets of 12 cells

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each, having a normal capacity of 50 ampere-hours per cell. They are grouped in boxes and so arranged that they can quickly be pushed into place inside the body of the carriage, connection being automatically made with the controller. The maximum speed is stated to be 20 miles an hour on a good road, and the weight of the vehicle, complete with batteries, is 1,650lb. Messrs. Morris and Salom appear to be purists in the matter of language, since, despising such hybrids as "autocar," they boldly call their carriage an "electrobat."

The Telegraphic Communication with South Africa.—The Postal Telegraph authorities having given notice of "considerable delay to South Africa owing to the interruption of the Aden-Zanzibar cable," a representative of the Press Association made inquiries at the offices of the Eastern Telegraph Company, and was informed that the delay was caused by the breaking of the cable between Aden and Zanzibar, on the East Coast route, which is the direct telegraph route to South Africa. So far as was known, the interruption had occurred near to Zanzibar, but a repairing vessel had been despatched and it was anticipated that the usual communication would be speedily restored. So far as the informant knew, the delay was not due to any disturbance in the Transvaal itself. The interruption has thrown extra work on the West Coast route, where the arrangements at the best do not afford facilities for great expedition. The delay has thus, in some instances, been as much as 24 hours. Government messages, however, have come through as usual, they having precedence of all others. It is stated that the last two private messages which came through from South Africa were one which left Johannesburg at 3.30 p.m. on Monday, and another which left at 5.20 p.m. the same day, reaching the office in London at midnight.

The Electrophone.—A representative of *London* has interviewed Mr. H. J. Booth, of the Electrophone Company. Seated in an armchair in the company's Board-room at Pelican House, Gerrard-street, W., he heard the performances at four London theatres. He was, however, apparently much disappointed to find that the electrophone was not more striking to look at. "It is," he says, "very insignificant, and looks no more imposing than a small cigar-box with wires attached. Few people would understand its use even if they happened to see it in a theatre or public building." After a certain amount of music, the interviewer of course suggested that Mr. Edison was the inventor. "Oh, no," replied Mr. Booth. "Most people seem to think that we owe the electrophone to the ingenuity of Mr. Edison. As a matter of fact, it is the invention of a Servian and an Austrian, and Mr. Edison did not to my knowledge see it until he saw it in Paris." The electrophone is not confined to theatres, but is also laid on to several churches. The consent of the deacons of the City Temple has, however, not yet been secured. Mr. Booth hopes soon to place instruments in the two Houses of Parliament in order to enable constituents in the provinces to listen to debates in which they are particularly interested, but which they cannot otherwise hear without travelling to London. This opens up a pleasing prospect for the local member, who is usually much more eloquent in country than he is in the House.

Alternating v. Direct Currents.—In the New York *Electrical Engineer* Mr. W. Baxter continues his advocacy of the continuous current. "The only extensive application," he says, "of the alternating current at the present time is for incandescent lighting. A few arc lights are also operated by it, but for this purpose it is far inferior to the direct current. Anyone desiring to instal an arc lighting plant would not take the alternating system into consideration for a moment. Arc lamps of this type are only used where they are so far apart or so few in number as not to justify the expense of a separate circuit." Mr. Baxter thinks very little of the prospects of the multiphase motor, and says that European engineers are so much in favour of the alternating system because "with them incandescent lighting is about the only practical application of electricity. It is true that they use a few arc lights and stationary motors, and a sprinkling of electric railways, but the development on these lines dwindles into insignificance when compared to what we are doing on this side of the Atlantic. Very few, even among those engaged in electrical work, are aware of the fact that in New York City alone there are several thousand motors used for manufacturing and for operating elevators, while small fan and sewing-machine motors are as numerous as flies around a candy store." It is further urged that "one of the principal objections to the alternating current is the increased difficulty of transmission, and yet we transmit energy by this system, and at the receiving end convert it into a direct current so that we may be able to make use of it. Would it not be a wiser policy to rectify the current before transmission and thus save, either in cost of construction, wire, or in higher efficiency of transmission? If it would be wise to go that far, would it not be still wiser to go one step farther and replace the alternator with a direct-current generator and thus save the extra loss in transformation as well as in transmission? Obviously the correct answer to these questions is, that if the direct current can be successfully used at as high an E.M.F. as the alternating it would be the one best adapted to our requirements."

"The Overhead Trolley Must Go."—Under this alarming heading the *Electrical Journal*, of Chicago, quotes from one of its daily contemporaries as follows: "If there is anything above or below this mundane sphere which should serve as a check to the speed of trolley lines in the centre of Chicago, it was last night's storm. And if the distinguished ordinance makers and franchise givers have a grain of sense, they will at once begin to mend their evil ways. It was as much as an honest man's life was worth to be on the streets last night. Broken telephone and telegraph wires hung across trolley lines, turning the whole city into an electrocution chair. The heavy current of the trolley lines passed to every contacting wire, establishing a perfect and deadly circuit, which interrupted telephonic and telegraphic communication and endangered human life. These conditions are possible with every big storm. They should warn the Council against indulging in further generosity to street railway companies. If the danger last night was great, what will it be when President Wheeler's trolley lines are strung along Clark-street from the south to Washington-street? And when Mr. Yerkes hypnotises his aldermanic subjects into giving him an overhead trolley loop down town? While the extension of electric transit lines may be a means of increasing the revenues of aldermen, it is extra menace to human existence and should cease forthwith. The overhead trolley must go." Speaking of the trolley car, a very practical use has been found for it in Newark, N.J., where a contract has been made with a leading bakery to deliver smoking hot bread in the early hours of the morning to points within 14 miles of that city. This work was formerly done by 50 delivery wagons, but it has been found that time and money can be saved by the new arrangement. To Jersey City alone 18 of these wagons have formerly been despatched; hereafter a certain number of them only will be employed to make the local delivery to the grocers, the supply being had

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from the trolley car on its arrival from Newark. The cars will be run at an hour of the night when they will be unobstructed and will not in any way interfere with the regular passenger service. The brewers are talking of utilising the trolley for similar purposes.

Germany and Austria.—The question of electric traction is at present receiving the consideration of the municipal authorities of Solingen. The four leading electrical engineering firms have each submitted plans for several projected lines. The municipal authorities of Coblenz have given their approval to a scheme for the construction of an electric tramway between the Rhine railway station in Coblenz and Ehrenbreitstein. It is also proposed to construct an electric tramway at Neumarkt, in Silesia, between the railway station and the town. A central electric lighting station has just been completed and put in operation at Gunsberg, a small town in Bavaria. The plant, which has been supplied by Messrs. Schuckert and Co., of Nuremberg, is driven by water power. A small steam-power plant has also been put in by way of reserve. Tenders are at present being invited for the electric lighting of the town of Brumath, in Alsace. It is proposed to establish a central station at Bernstadt. The electric lighting question is also under consideration at Ludwigsburg. The municipal authorities of Coblenz, in addition to the tramway scheme mentioned above, have also appointed a committee to inquire into the electric lighting question. Telephonic communication is now available between this city and Velten. A central electric lighting station is rapidly approaching completion at Predazzo in the Tyrol; water power is being used. Tenders are about to be invited for the establishment of a central station at Brunn. The local authorities of Rumberg have just decided upon the establishment of a municipal central station in the town. It is stated that Messrs. Schuckert and Co., of Nuremberg, in conjunction with two other firms, have undertaken the construction of the Gosan electric railway near Linz. The line will be about 60 kilometres long.

Tyneside Geographical Society.—On December 30 a lecture was delivered by Mr. Philip Dawson, A.M.I.C.E., A.I.E.E., member of Tramways Institute of Great Britain and Ireland, on the subject of "Electric Traction" in the Lovaine Hall of the Tyneside Geographical Society, Newcastle. Captain Noble presided, and there was an unusually large audience. In the course of his lecture Mr. Dawson said: "It is a matter of common knowledge that animal power has long since proved wholly inadequate for the requirements of modern metropolitan life. There is no engineering question of more pressing present interest to the British public at large than the extension of rapid transit facilities. Until a very recent date it was necessary for us to look wholly to America for those later developments in rapid transit extension which have led to the introduction of improved mechanical traction on a large scale. The results obtained have been so rapid and surprising, and, as a whole, so satisfactory, that they merit our most careful attention. In 1890 there were 2,523 miles of electrically operated track and 5,592 motor cars within the United States of America and Canada. In July, 1895, 10,752 miles of trolley wire had been erected, furnishing current for 35,004 electric cars. Approximately, these figures mean an investment in equipment of £50,000,000 sterling. In 1890 about 60 miles of electric lines were in operation. To-day there are approximately 500 miles of elevated conductors and 1,500 motor-equipped cars, while the lines under contract easily equal, if they do not considerably exceed, the sum total of all that has heretofore been completed. By far the greater proportion of European electric tramway installations are to be found in Germany, but during the past year great activity has been shown in France as well. Comparatively little has yet been done in the British Isles, but there is every present appearance of extensive installations being shortly undertaken. Dublin, Bristol, and Coventry are now running. The electric tramways of the Isle of Man, South Staffordshire, Leeds, and Guernsey are undoubted successes. On the question of tramways in general, the attitude taken in Great Britains is distinctly opposed to that of all other countries. British regulations are by far the most severe, and is difficult to see why their stringency should not be relaxed to some extent. With the gradual change from animal to mechanical means of traction, most, if not all, of the objectional features of the tramway have been eliminated. If American and Continental experience has proved anything, electricity surpasses all other methods of motive power in its general fitness for tramway and light railway service. It admits of a constant service of comparatively light cars or trains at reasonable cost, of wide variations of speed, of elasticity sufficient to meet the demands of great temporary increase in passenger traffic, of re-equipment without extensive interference with the highway, existing cars, or any public service. It is essentially clean, safe, and controllable. All that has been said is especially applicable to the trolley wire system, which is the only one that has received any wide acceptance. The conduit has still to demonstrate its efficiency on a large scale. The trolley wire avoids the great expense and manifold disadvantages attendant upon reconstruction of roadway, and interference with existing sub-surface sewers, gas and water pipes and mains, telegraph, telephone, and lighting cables, etc." After referring to the Bristol tramways, Mr. Dawson said that on the Continent Genoa with its marble palaces, Milan with its magnificent piazzas and Duomo, Rome, Florence, Dresden, Leipzig, Nuremburg, Hamburg, Bremen, Brussels, Havre, Marseilles, Rouen, Lyons, etc., do not find that well-established trolley lines spoil their beauties. In conclusion, he remarked: "A few words must be said as to the comparative merits of electricity as against cable traction. For the broad and straight thoroughfares of great cities, where enormous traffic is to be handled and heavy grades to be worked, the cable is still unequalled. If, however, the traffic is not so great as to assure a service of cars or trains one minute or less apart, the cable is hopelessly behind electrical motive power. The tremendous expense of a cable installation can only be met where these favourable conditions are to be found. Curves are well nigh fatal to the economical operation of a cable line, and it is utterly unsuited to a service which requires that outlying districts be brought into touch with metropolitan centres. This is so much the case that America furnishes numerous illustrations of cable lines abandoned for electric trolley lines. I may cite St. Louis, Denver, San Francisco, St. Paul, and Minneapolis as conspicuous examples of the substitution of electric power for cable. The cable has no elasticity. The electric car can be run effectively where no other known means of traction will meet expenses. It may safely be taken that few, if any, cable tramways will be equipped in the future, and those only in the great arteries of traffic of the greatest cities of the world. I can see no reasonable alternative to the electric motor. It possesses the maximum of advantages and the minimum of drawbacks. It has a future unquestionably in this country and the Continent as great as its present in America, and I feel assured that no opposition can be so strong as to bar its progress." A discussion followed.

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AYR ELECTRICITY WORKS.

Town after town is municipalising its artificial lighting, and in this manner adopting the electric light. The latest burgh to enter the ranks of the electrically lighted is Ayr, the capital of the county of Ayr. This town is one of the best known in Scotland, standing on a magnificent site on

BAILIE WILLIAM URE,
PRESENT CHAIRMAN OF ELECTRIC LIGHTING COMMITTEE.

the sea-coast at the head of the bay of Ayr. Its charter of incorporation was first granted in 1202 by William the Lion, who conferred upon the burgesses the whole of the lands of the parish with many valuable privileges. This charter was confirmed by Alexander II., who added the adjoining parish of Alloway, and these charters were

MR. H. D. WILLOCK, PROVOST OF AYR.

ratified by Robert Bruce. The lovers of Ayr say its bay is unrivalled for scenery. To the north are the islands of Cumbrae, the Bute hills, and in the distance the Argyllshire mountains, with mighty Ben Lomond towering over all; to the west, across the sea, is seen the Irish coast, and near the Ayrshire coast is the Craig of Ailsa, not to mention the Isle of Arran, and away behind that the Mull of Cantyre. Ayr can boast a long roll of historic names, three of which will last while history endures—Burns the poet, Scotus the scholar, and McAdam the engineer.

A retrospect of the history of the electric lighting movement in Ayr shows that as far back as 1878 a Mr. Horton, agent for Gramme's patent electric machine, gave two exhibitions of the light in Ayr, and at that time admiration was expressed on all hands at its brilliancy and power. Several members of the Town Council then expressed a strong desire that at least an experiment on a small scale might be made at some part of the town specially adapted for the use of the light, as it was thought that the exhibitions had not fully solved the problem of the applicability of the system to purposes of street lighting. This was Ayr's first experience of electric light, and apparently nothing resulted from it. In 1889, when the great boom occurred among electric lighting companies, during which a number of them made raids upon several of the cities and burghs of Scotland, the ancient burgh of Ayr came in, amongst others, for a share of the attentions of these companies. Two companies—the Scottish House-to-House Electric Company, Limited, and Messrs. Norman

MR. JAMES SMITH,
FIRST CHAIRMAN OF ELECTRIC LIGHTING COMMITTEE

and Sons, Limited—at that time wrote to the town clerk of Ayr intimating that they intended to apply to the Board of Trade for a provisional order for the electric lighting of the burgh. Both letters were laid before the Works Committee of the Ayr Town Council on July 4, 1889, and were remitted by that committee to the Lighting Committee. A special meeting of the Town Council was convened for August 12, to take into consideration the action of the two companies, and also to consider the whole question of electric lighting, with a view to the introduction of electricity as a means of lighting the burgh. The matter was freely and fully discussed at this meeting, and a motion to the effect that the Commissioners should take the lighting of the burgh into their own hands, and thereby preclude any company from coming in without the consent of the Commissioners, was unanimously carried. It was also at the same meeting remitted to the Lighting Committee with powers to obtain, and thereafter carry out, a provisional order for the lighting of the burgh by electricity. The committee, however, was in no hurry to press on the work, hoping to gain experience by delay, the more so, as at this time most of the installations then in progress were being promoted by companies—few burghs in England and none in Scotland having undertaken their own electric lighting.

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At a subsequent meeting of the Town Council held on November 14, 1889, it was unanimously agreed to at once take out a provisional order in the name of the Commissioners, and thus thoroughly check any encroachment by any company, and a provisional order was accordingly obtained by the Commissioners. Having armed themselves with this order, the committee proceeded to leisurely discuss the question of ways and means and to collect information as to the best and most profitable system to adopt. The impression was then pretty general that sufficient motive power for an installation could be obtained from either of the Rivers Ayr or Doon, and as the committee considered that water power was not only the best, but also cheapest, they availed themselves of the services of Mr. Frank Christie, of Chelmsford, a hydraulic engineer of considerable experience, in making a survey of both rivers to ascertain their capacity for the purpose. In the beginning of 1894 Mr. Christie submitted a very exhaustive report, which demonstrated clearly that all that could be got out of either of the two rivers was only about 500 h.p., at a cost of about £18,000. Had more than 500 h.p. been required at a future time it would have been necessary, therefore, to supplement the water power with steam power. This idea was eventually abandoned.

During the interval between Mr. Christie's survey and report the committee, who were acting on the defensive rather than the aggressive, had been compelled to make application on two occasions for an extension of their provisional order, both of which applications—the first in June, 1892, and the second in 1893—were granted, and early in 1894 the committee resolved to bring the matter to a final issue. With this end in view they commissioned Mr. John Eaglesham, the burgh surveyor, to visit Leeds, Blackpool, and one or two other places where there had been electric light stations built; and when that gentleman returned from his tour of inspection he reported so favourably of the system adopted in Leeds and Blackpool, and also of Mr. Robert Hammond, the engineer who had carried through the work connected with these installations, that the Commissioners commissioned Mr. Hammond to survey the burgh and draw up a report. This Mr. Hammond did, and his report was submitted to the Commissioners at their meeting in May. At this meeting an offer was submitted by the Caledonian Electric Supply Company, Edinburgh, to make terms with the Corporation whereby they would take a transfer or a lease of the provisional order. A lengthy discussion ensued, during which several of the Commissioners expressed themselves in favour of making terms with the company, but it was finally decided by a majority of 10 votes to 7 to keep the matter in the hands of the Commissioners, and it was left to the Lighting Committee to carry out the arrangements for giving effect to the resolution.

Site of the Works.

The first matter to which the committee turned their attention was the fixing upon a site for the erection of the works, and at the meeting of the Council held in June, 1894, full power was granted to them to fix upon and purchase a suitable site. In July the intimation was authoritatively made that the committee had fixed upon a vacant space of ground, belonging to the Corporation, situated in South Harbour-street, near the barracks, and it was said that by utilising this ground for the purpose upwards of £1,000 would be saved to the town. Mr. Hammond, the engineer, strongly approved of this site. A difficulty, however, arose when the Commissioners negotiated for the purchase of a piece of ground adjoining, which was considered necessary for further extensions which might require to be made in future, and the site was abandoned. Several other sites were under consideration, and the committee finally selected a site in Mill-street, situated on the south bank of the River Ayr, at a cost of £1,550. The borings on the site showed that satisfactory foundations would be obtained.

Cost of Plant, Buildings, etc.

Tenders having been invited for the supplying of plant, etc., no less than 49 were received. Some of the tenders were for the whole of the projected plant and works, while others were for parts only. The lowest offer by one firm for the complete work was £12,760, while the lowest offers from the various firms for the different parts of the work amounted to £11,834. Considering that almost £900 could be saved by dividing the work into sections, the committee felt justified in following this course, and the tenders were accepted as follow:

Plant.

Part I. of Section A—boiler-house plant: Messrs. Penman and Co., Glasgow, £950

Part II. of Section A—piping, etc, in connection with boiler-house plant: the Corporation undertook under the supervision of Mr. Hammond and Mr. Pink at a probable cost of £800.

Section B—engine house plant: Messrs. Siemens Bros. and Co., Limited, London, £5,940.

Sections C and F—switchboards and instruments and arc lamps, posts, etc.: Messrs. John Fowler and Co., Limited, Leeds, £988. 5s.

Section D—cables and culverts: Callender Bitumen Telegraph and Waterproof Company, Limited, London, £1,842. 18s. 9d.

Section E—transformers and boxes: Messrs Swinburne and Co., Limited, Teddington, £420.

Section G—meters: Messrs. S. Z. de Ferranti, Limited, London, £590. 13s.

Section H—travelling crane, etc: Messrs. Carrick and Ritchie, Edinburgh, £192. 10s.

Buildings.

Excavator, brick, and mason's work: Mr. Robt. Hutchison, £3,303. 6s. 4d.

Carpenter, joiner, and painter's work: Messrs. D. and J. Milligan, Ayr, £1,146. 13s. 4d.

Plumber and slater's work: Messrs. W. Highet and Son, Ayr, £356. 10s.

These are the original prices in the tenders without the extras which have inevitably crept in. One extra in particular is worthy of mention; it is the sum of £990. 12s. 4d., which was involved in an extension of the electric main along Miller-road and Alloway-place, a district not included in the original area to be lighted. The figures given above for purchase of site, plant, and buildings, and including the extra sum for the extension of the main referred to, total up £19,071. 8s. 9d., and this, of course, does not include the engineer's fee nor the salaries of the superintendents appointed to look after the erection of the plant and buildings. Another item to add is the interest on the sum of £15,000 which the Corporation were authorised to borrow for a period of 30 years. Taking all these items into consideration, along with the extras, the total cost may be estimated at over £20,000. Subsequently the Commissioners were authorised to borrow an additional £5,000, thus bringing the amount borrowed up to £20,000.

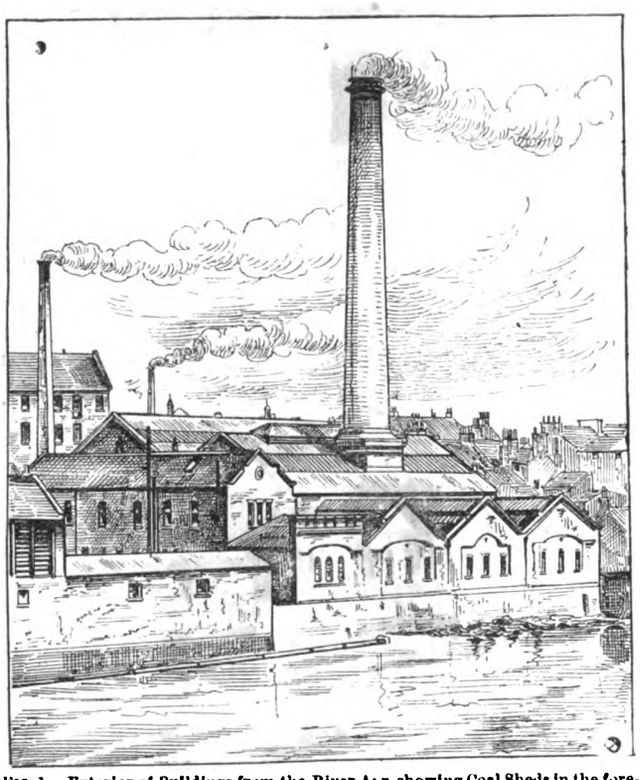

Fig. 1.—Exterior of Buildings from the River Ayr, showing Coal Sheds in the foreground, Boiler-house and Engine-house behind, and the Office Wing to the left.

Description of Buildings.

The designs for the building were prepared by Mr. H. V.

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Eaglesham, architect, and this gentleman has also superintended the carrying out of the work. The buildings are entirely of brick, lined inside with Brodie's pressed brick from Sanquhar. On the ground floor are situated the engine-room, measuring 69ft. by 34ft. and 41ft. high to the apex of the roof; the boiler-room, 69ft. by 45ft. 6in. and 33ft. high; the condenser pit, 24ft. by 16ft.; the test-room, 12ft. by 18ft.; coal-sheds, 69ft. by 25ft.; workshop, 27ft. by 16ft.; mess-room, 10ft. by 16ft.; store, 9ft. by 16ft.; lavatory, water-closets, etc. Upstairs are the offices, switch-room, lavatory, etc.

The interior of the engine-room presents a fine appearance. Running right round is an enamelled brick dado, 5ft. high, surmounted by a band of blue bricks. At a height of 22ft. there is a travelling crane, running on an iron rail, carried on piers 3ft. square and arched between. These piers and archings are also of enamelled brick, and are founded on the solid rock at a depth of about 15ft. below the level of the floor. The foundations of the engines are also on the solid rock, and are brought up to the level with concrete. At the level of the crane rail there is a wooden cornice which extends round the whole room. The roof is formed of iron couples, with pitch-pine purlins and chamfered boarding. The roof-light extends the full length on both sides of the apex of the roof. Ventilation is obtained by means of two of Boyle's patent ventilators. The floor is formed with concrete tinted with oxide of iron. The wall at one end of the engine-room is only temporary, and is built so as to allow of future extension.

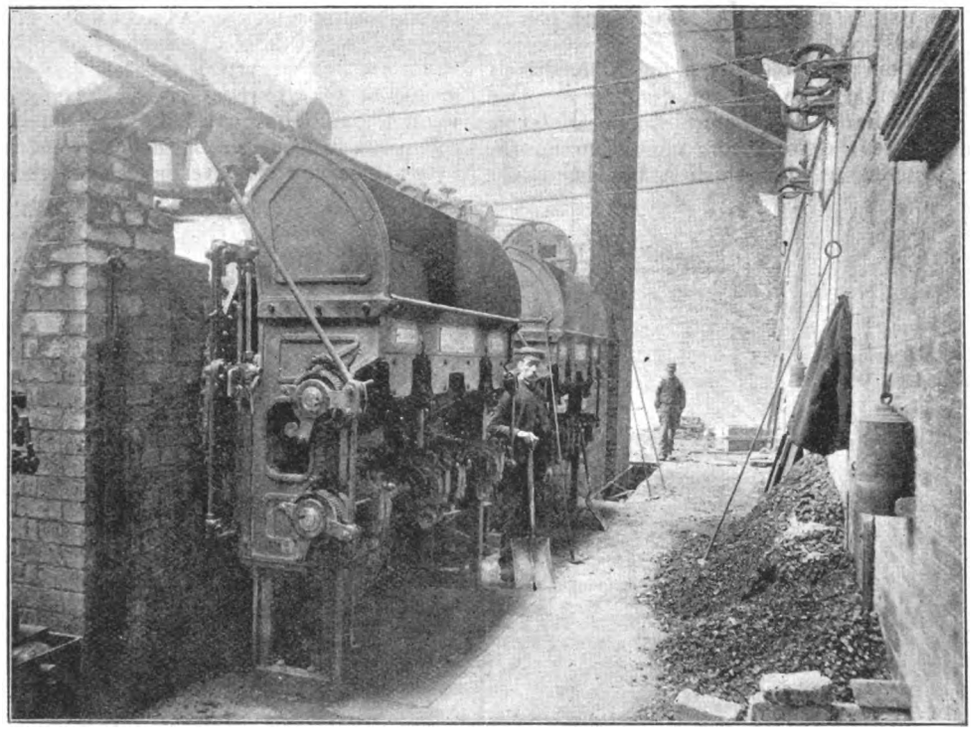

FIG. 2.—Front View of Boilers, showing Vicar's Mechanical Stokers.

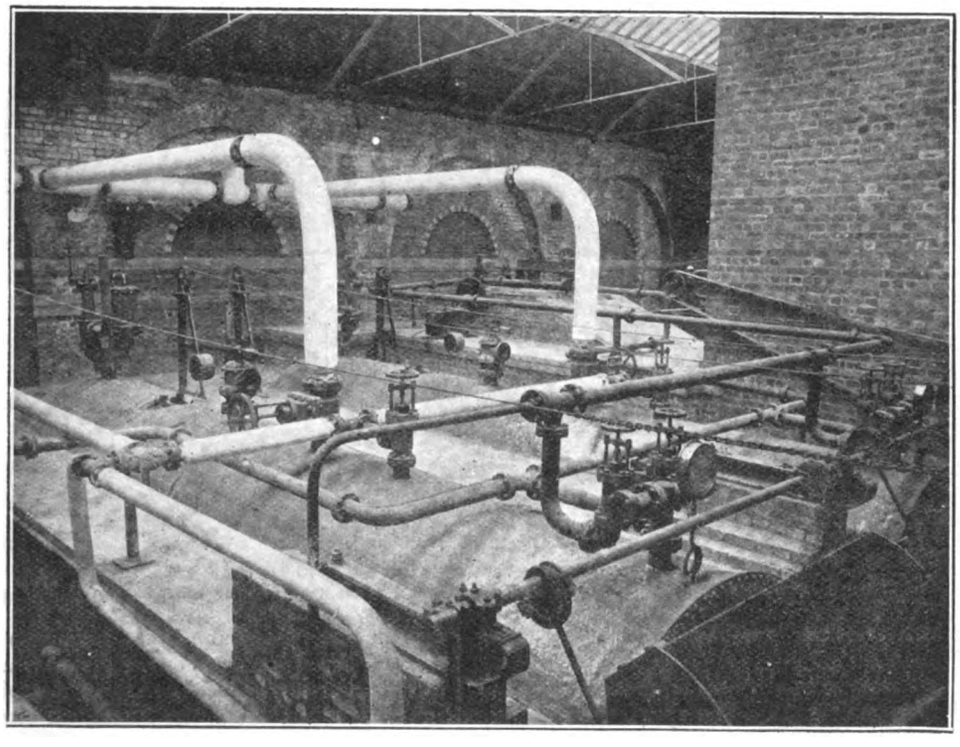

FIG. 3.—Top View of Boilers, showing Boiler Connections.

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Adjoining the engine-room is the test-room, which is lined with narrow lining and stained and varnished.

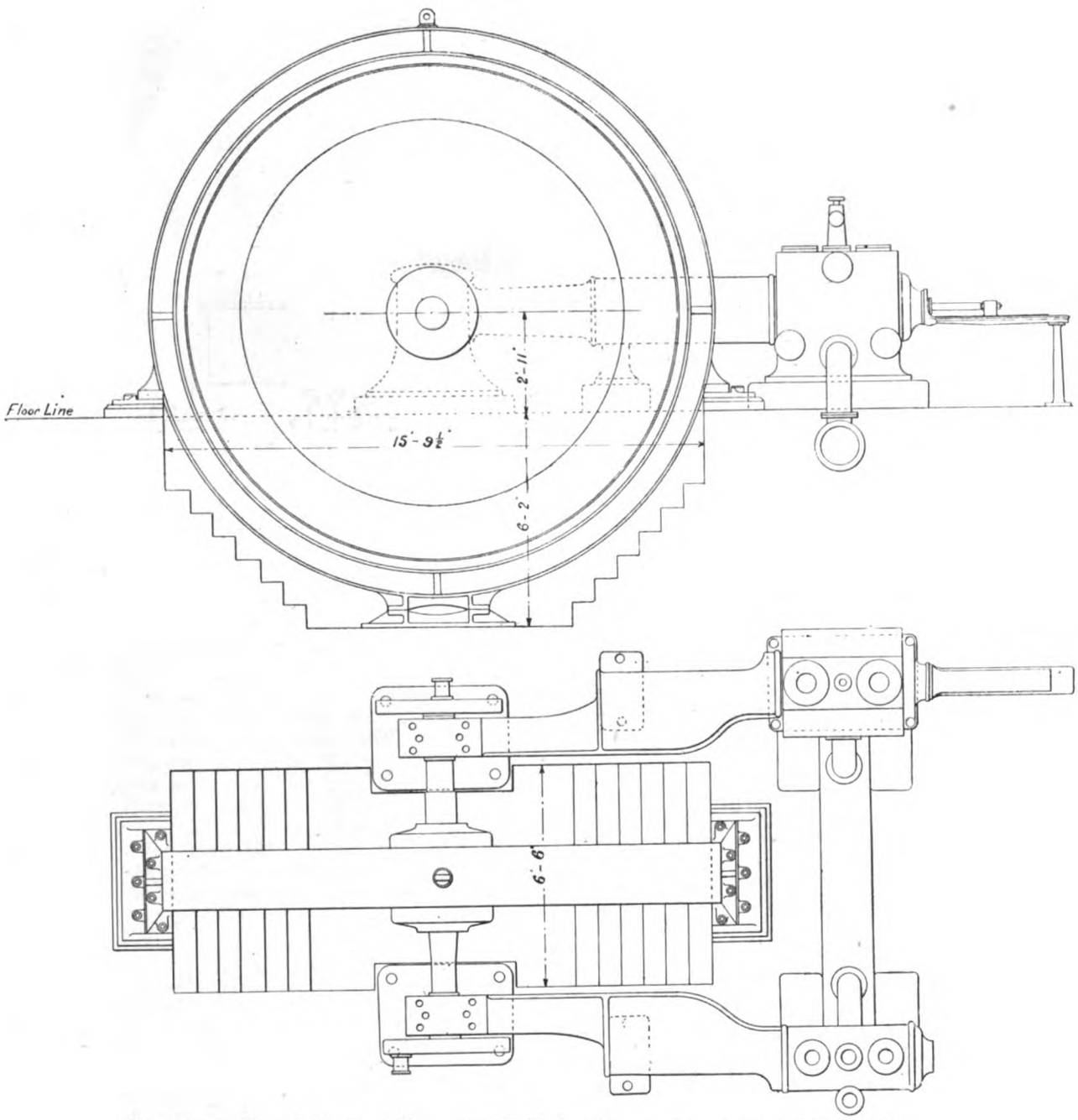
The boiler-room adjoins the engine-room, and has a roof of similar construction, the only difference being in the means of ventilation, the boiler-room being ventilated by a louvred ventilator. The chimney stalk, which is 12ft. square at the base, rises to a height of 120ft., and has its foundation on the solid rock.

The coal-sheds adjoin the boiler-room, and immediately behind the boilers openings are left for drawing the coal from the coal-sheds to feed the mechanical stoker. Entering off the boiler-room are the workshop, mess-room for the employés, store, condenser pit—which is 6ft. below the level of the boiler-room floor—and the lavatory and water-closets.

The private entrance to the offices is at the south-east corner of the buildings (Fig. 1). The stair leading to the switchroom and offices is of pitch pine, with wooden balusters and handrail. At the top of the stair to the right is the switchroom, and to the left a long corridor, with electrician's, engineer's, and general offices, and lavatory entering off it. The switchroom is open on the side towards the engine-room, having on that side only a wooden balustrade. From it an excellent view of the engine-room can be obtained. The offices are supplied with telephone connection, and are fitted in first-class style.

Steam Generating Plant.

The boiler-house plant, as already stated, was supplied by Messrs. Penman and Co., of Glasgow. The boilers are two in number, of the Lancashire type, each 28ft. long by 7ft., with two flues each 2ft. 9in. diameter, with four water-circulating cross tubes in each. The boilers are constructed throughout of mild selected steel boiler plates; each circumferential ring of the shell is made of one plate, the longitudinal seams are butt-straped in and out and riveted together by means of four rows of rivets, the circular seams are lap-jointed and double riveted. The flues are on the anti-collapsive flanged-seam principle, constructed throughout by machinery. The rivet holes throughout the boiler were drilled after the plates were bent into position, and the riveting throughout performed by hydraulic power. They were constructed under the supervision of the Engine Boiler and Employers' Liability Insurance Company, and were designed for a daily working pressure of 140lb. per square inch.



FIGS. 4 AND 5.—Plan and Elevation of Siemens 100-K.W. Flywheel Alternator driven by Marshall Horizontal Engine.

Each boiler is capable of supplying steam to a 250-h.p engine at full load. Each boiler is fitted with a Vicars mechanical stoker, by which an almost smokeless fire is obtained. These stokers, which can be seen in Fig. 2, are driven by a five-kilowatt, or about 8 h.p., electro-motor, supplied by Messrs. Mavor and Coulson, Glasgow, and great care has been taken to avoid any sudden

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rush of current on switching on the motor, which would cause a temporary blink in the lights.

In these Vicars stokers the fuel is fed from a hopper into two boxes, from which it is gradually pushed by alternately reciprocating plungers into the furnace; it then falls on the firebars, which by a slow reciprocating movement carry the burning mass gradually backward. The supply of fuel and the travel of the firebars can be regulated with facility, independently of each other, by means of a simple mechanical combination. The travel of the bars may also be adjusted in length up to 4in. The alternate firebars are lowered and drawn towards the front of the furnace, and then all the firebars travel inwards together. The motion is derived from a driving shaft, on each end of which an eccentric is fixed, working a ratchet wheel and pawl, by which a transverse shaft at the front is caused to

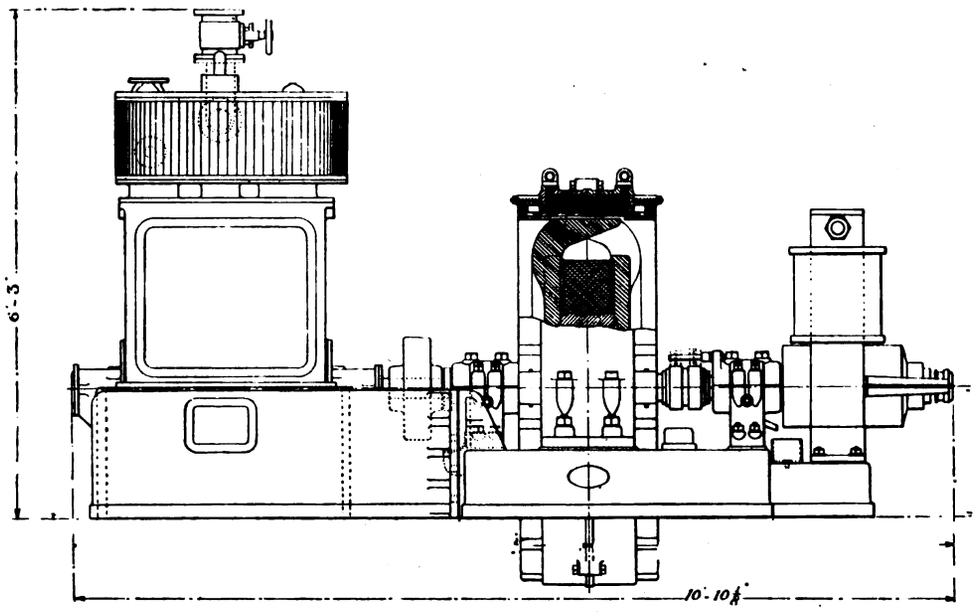

FIG. 6.—Sectional Elevation of 25 K.W. Siemens-Bellis Steam Alternator.

revolve. By means of cams on this shaft the horizontal movements of the firebars are effected. The speed of this motion can be regulated to from 30 to 120 turns of the shaft per hour. The furnace can, when required, be fed by hand through a doorway between the two pushing rams.

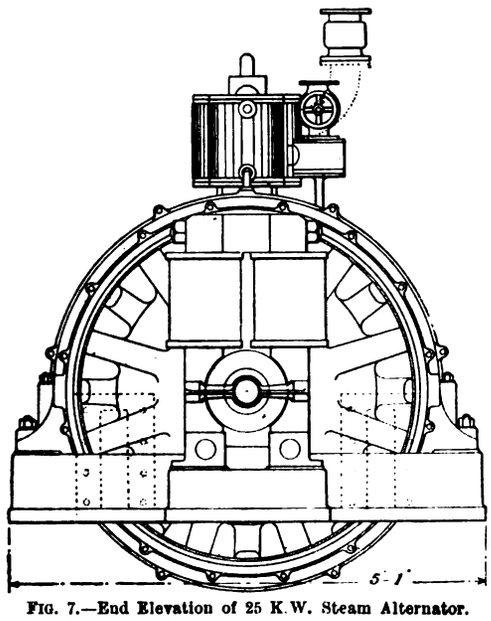

FIG. 7.—End Elevation of 25 K.W. Steam Alternator.

The water for the boilers is drawn from a hot-well underground, capable of holding 3,000 gallons, into which the overflow from the condenser and the hot-drains run. The water is forced into the boilers either by an injector capable of supply 1,200 gallons per hour or by a Worthington pump of the same capacity. The feed-water is heated before entering the boilers by a fuel economiser, consisting of 48 tubes, constructed by E. Green and Son, Limited, of Manchester and Wakefield, which is placed in the flue between the boilers and chimney, suitable provision being made for examination or cleaning purposes without stoppage of the boilers. The apparatus is constructed from strengthened patterns throughout and fitted with a number of recently patented improvements.

The condensing plant was supplied by Messrs. Alley and Maclellan, of Glasgow. The air-pump and jet condenser is of the horizontal direct double-acting type, of ample capacity for maintaining a vacuum of 26in. when the engines are developing full power. Steam is taken direct from the boilers to the cylinder, which exhausts direct into the condenser. The injection water is taken direct from the river, and is discharged into a hot-well. A separate connection is made to the water-main for the purpose of getting a vacuum when starting the pump. By an arrangement of valves the engines may exhaust either into atmosphere or into condenser as required. Provision is made so that a duplicate pump and condenser may be put down at a later date. The condenser pit is 6ft. below the engine-floor surface. The condensing water is drawn from the dam about 300 yards up the river through a 12in. pipe, and has an overflow of the same dimensions. From the main existing pipe and the intake and overflow pipes two services are made for future connections.

The steam and exhaust pipe work was done by men employed by the burgh, under the supervision of the burgh engineer. Fig. 3 shows these pipes over the two boilers, and the connections to the feed-pumps, etc.

GENERATING PLANT.

Messrs. Siemens Bros. and Co. obtained the contract for this part of the work, and supplied two large alternator sets capable of giving 100 kilowatts each, one smaller 25-kilowatt set, with its own exciter on the same shaft, and two exciter sets of 10 kilowatts.

The two engines for driving the large flywheel alternators (Figs. 4 and 5) were manufactured by Marshall, Sons, and Co., Limited, of Gainsborough. They are of the horizontal coupled compound type, each with high-pressure cylinder 14½in. diameter, low-pressure cylinder 25in. diameter, both having 32in. stroke. The cylinders are steam jacketed, the inner barrel being cast separately of a special hard mixture of iron, and tightly forced into the main casting of the cylinder. The clearances are carefully worked out, and the inside faces of the covers and both sides of the pistons are turned and polished. The governors are Dr. Proëll's patent, with two valve-releasing gear and Corliss exhaust-valves, and the governors are chain-driven direct from the crankshaft. The crankshaft bearings are of extra strength, and are arranged with adjustment, not only at the sides, but underneath, so that the crankshaft can always be adjusted, as these engines have the armatures of the dynamos fitted on the shaft in the place of a flywheel. All the wearing parts

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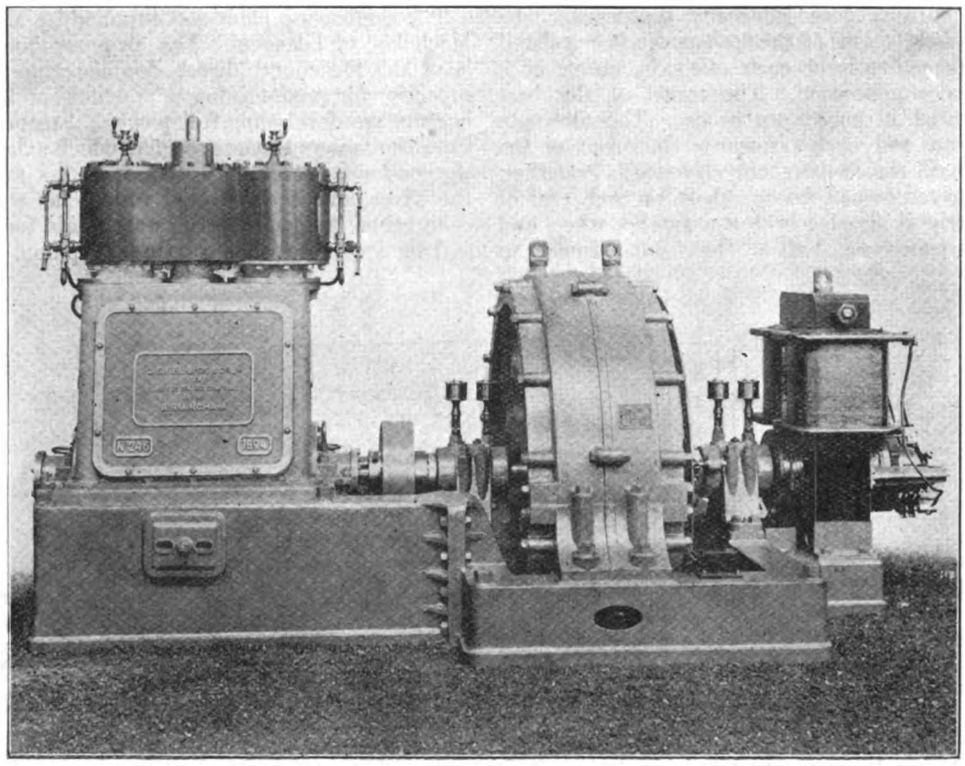
are amply large. Brass bushes and neck rings are provided for all rods, with patent metallic packing for the stuffing-boxes. Pillars and handrails are placed round the discs, connecting rods, and dynamos, and the engines throughout are fitted up in the first-class style for which the firm are renowned. These engines, running at 95 revolutions per minute, are each capable of giving 175 i.h.p. when supplied with steam of 125lb. pressure. The whole of the engines have their bearings fitted with special oil-pumps, and the oil is forced through all bearings at pressure of 2lb. to the inch. All the oil is collected at the base of the engines and runs by a common drain to a small sump in the corner of the engine-house, from which it is pumped into filters, and after being filtered is ready for using again. All waste is thus avoided.

The alternators, which are of the Siemens O $^{170}/_{12}$ type, are built up as flywheels to these engines. The general outlines of these alternators and engines can be seen from Figs. 4 and 5, but unfortunately the details of the alternators are not shown. The field magnets, which are fixed to the rim of the engine flywheel, revolve, while the armature, which is fixed, is arranged outside the magnets.



Belliss 50-h.p. Engine coupled to Siemens 95-K.W. Alternator and Exciter.

The field-magnet system is built up on the cast-iron flywheel in the following manner On each ide of the rim are clamped four sections of a cast-steel check, having a number of pole-pieces projecting inwards across the external surface of the wheel, as shown in Fig. 6. The poles, bolted on the opposite side, nterleave with these, so as to form a series of 76 alternate poles. The exciting coil is wound on the cast-iron rim, and held in position by the steel cheeks. A cast-iron rim, 17ft. 3in. in diameter, surrounds the magnet system and supports the armature laminations. The

FIG. 9.—View of the Conduit for High-Tension Mains, showing Draw Box

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wrought-iron sheet presents a smooth surface to the magnets, and to the face of it are bolted, by means of special brackets, 76 coils of flat copper strip, wound edge-ways. The flywheel is not keyed to the main shaft, but is driven by means of two spring couplings placed one on each side of the flywheel. The wheel has projecting arms on each side, which come in the recesses of a star-shaped casting keyed to the shaft. Between the adjacent arms thus formed, steel springs are placed, which give a flexible drive, and hence reduces the synchronising current. The output of each of these alternators is 50 amperes at 2,000 volts, the frequency being 60 ~ per second.

The other three engines were supplied by Messrs. G. E. Belliss and Co. The engine for driving the day-load alternators is capable of giving an ordinary load 50 i.h.p., and will keep up 60 i.h.p. for a short time on emergencies, with a steam pressure of 125lb. exhausting into the condenser at a speed of 360 revolutions. When the condenser is not in use, the boiler pressure will be increased to 140lb. enables the engine to be run with a minimum of attention. Another special feature of these engines is the arrangement of the slide valves, requiring one eccentric and rod only.

The alternator coupled to this engine is of Siemens's O $^{50}/_{12}$ type, of same general design as the large alternators described above. It can give an output of 12·5 amperes at 2,000 volts. The section (Fig. 6) shows the construction of this machine. The exciter coupled to the extensions of the shaft is a direct-current machine of the H. B. $^{12}/_{8}$ type. The output of this exciter is 30 amperes at 100 volts.

The two smaller sets for exciting the large alternators consist of two Belliss engines, generally the same in their leading features as the day-load engines above described, but of smaller dimensions. They were designed to indicate 20 h.p. ordinarily and 30 h.p. on emergency, at a speed of 500 revolutions, exhausting into condenser. They drive Siemens H. B. $^{9}/_{18}$ dynamos giving out 100 amperes at 100 volts. Either of these is capable of exciting all the alternators at one time.

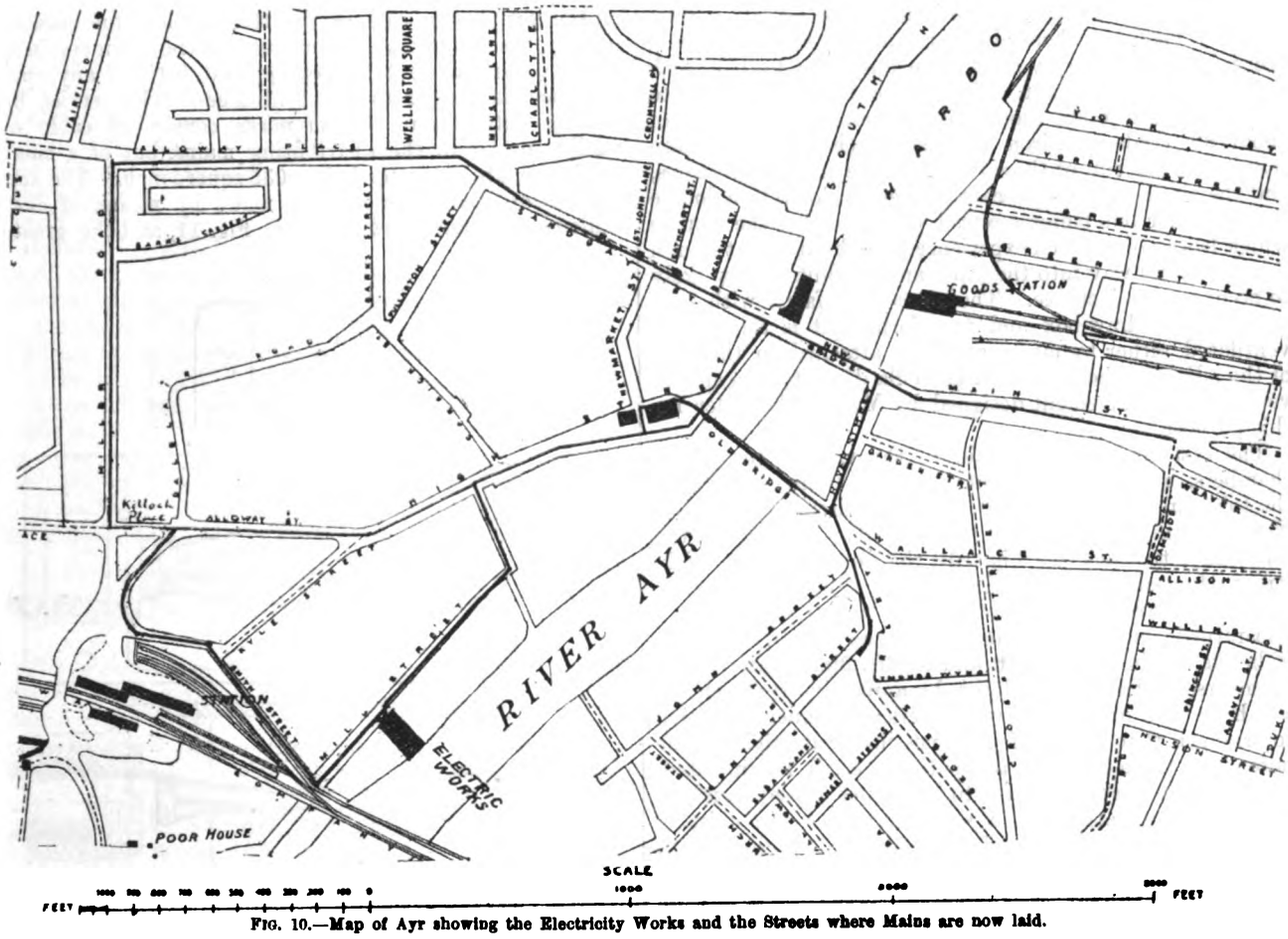

FIG. 10.—Map of Ayr showing the Electricity Works and the Streets where Mains are now laid.

This output was satisfactorily maintained on the tests of the combined sets at the makers' works. At the same time the performance of the engine on the governor was tested with the following results. On the full load being switched off suddenly the momentary increase of speed was found to be only 4 per cent., the permanent variation being the same. For an engine fitted with throttle-valve governor this result, so far as the momentary increase is concerned, is very good. It is largely due to the large flywheel effect of the heavy alternator in conjunction with the excellence of the governing arrangements. Two views of this engine and alternator are shown (Figs. 6 and 7), and Fig. 8 is a perspective view of the same.

There are two sets of cylinders, the cranks being set opposite each other, and steam being admitted simultaneously to the top of one cylinder and the bottom of the other. The reciprocating parts are balanced, and thus a high speed is made possible without setting up undue vibration. The high-pressure cylinders are 7½in. diameter, and the low-pressure cylinders 12in. diameter with 6in. stroke. These engines are fitted with a system of forced lubrication, which not only conduces to their noiseless working, but being essentially automatic in its action

SWITCHBOARD.

This was made, under the Lowrie-Hall patents, by Messrs. J. Fowler and Co., of Leeds. It is arranged for three alternators and two circuits, with provision for extension up to six alternators and four circuits. The board is designed to maintain high insulation, the bases being entirely of slate, and the metallic portions of the switch plugs are carefully insulated and fixed on ebonite bases. The form of the plugs and that of their corresponding terminals is that of a rectangle, nearly square in dimensions, in order to prevent the plug being inserted wrongly. The switchroom is so arranged as to be easily accessible at the back for examination of connections, etc., the oak frame on which the switch panels are fixed forming a false wall to the switchroom. The switchboard is fitted with signalling arrangement, with gong attached, having a suitable dial in the engine-room. The board also includes a complete synchronising arrangement and hospital shunt for occasionally running one circuit separately in connection with any alternator by means of jack cords and flexible cables. A suitable artificial load is provided for testing the plant prior to the running on the lights, and consisting of a resistance frame arranged with switches, so that loads of 25, 50, 75, or 100 kilowatts can

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be obtained at will. The whole of the board, in addition, being highly insulated is thoroughly protected from accidental contact on the part of the attendant. The actual size of the switchboard is 12ft. wide by 11ft. 6in. high.

Distribution.

The whole of the mains and cable were manufactured and laid by the Callender's Bitumen Telegraph and Waterproof Company, Limited. From the central station in Mill-street, where the current is generated at 2,000 volts, it is carried by means of concentric cables to certain points in the town, at which transforming apparatus is placed in underground chambers. It is then converted into a low-pressure current, and thence distributed along the network of low-tension mains to the various consumers, to whom it is supplied at a pressure of 100 volts. Two separate circuits leave the works, each one contained in a separate conduit. This conduit consists of a cast-iron pipe having 4in. internal diameter. It is made to the Post Office specification as to weight and thickness, and is dressed both inside and out with Dr. Angus Smith's preservative compound. The pipes themselves are in lengths of 9ft., and are joined together by spun yarn and blue lead at each socket and faucet joint. Great care has been taken to make all these joints thoroughly sound. At intervals of about 80 yards cast-iron draw-boxes (Fig. 9) have been inserted in the run of these pipes. These are solid castings, and the manhole giving access to them is closed by a double lid, the inner one being screwed down, so that the trouble which has so often been experienced in other towns through gas finding its way into the pipes and conduits is not likely to occur in this instance. The outer lid is faced with concrete. Each draw-box and transformer-pit is thoroughly ventilated, either by means of a pipe attached to the wall of the adjoining houses or (in the villa district) by a special ventilating arrangement designed by Messrs. Callender for this purpose.

The cast-iron pipes are laid to the various converting chambers, and, as at present arranged, there are, within the town area, three of these on No. 1 circuit and four on No. 2, making seven in all. These seven are placed in the following situations (see Fig. 10): the Town Head, Garrick-street, Hope-street, Town Hall North, Town Hall South, Newmarket-street, Cross-street. The actual transforming apparatus is enclosed in a small box or chamber constructed of bricks, set in cement, 4ft. 4in. by 4ft. 8in. in size. These chambers, or boxes, are closed by a massive cast-iron lid, and have both inner and outer covers; the inner one being so arranged that it is, as far as possible, watertight. The outer is in three sections, so as to be easily manipulated. Every endeavour was made to construct these chambers under the footpath, but in some instances the existing cellars and other obstructions rendered it necessary to place them in the roadway. The length of each of the high-pressure circuits is about 1,160 yards. The feeding mains are of Callender's high-pressure concentric cables, having a sectional area on each conductor of ·062 square inch. Each of the conductors is insulated by a solid dielectric of bitumenised fibre, and the outer dielectric is sheathed with a solid tube of lead, which is made direct on the cable under great hydraulic pressure. The cable is then yarn braided and thoroughly compounded, so that the lead has a mechanical protection between it and the iron pipes. The pipe line was first laid complete, and the lengths were then carefully measured between the various boxes and transformer chambers. The high-tension cables were then made in exact lengths to suit the work, so that the joints which were necessary to unite the factory lengths into continuous mains when laid should in all cases occur at draw-boxes, so as to be easily available at any time for inspection or otherwise.

The quantity of cable provided for under the original contract was 3,080 yards, and this has been laid. In addition to this it has already been found necessary to extend the mains to the residential district, and 2,060 yards of similar high-pressure cable have been laid, making 5,140 yards in all, or nearly three miles. No difference in the system has been made in the residential district, except that the cast-iron pipes used have been 3in. in diameter. The low-pressure mains radiate from the transforming-chambers throughout most of the important streets in the burgh, and consumers are connected to these mains. The cables used for these low-pressure mains are also Callender concentric and lead-sheathed, and, so far, differ in no respect from the high-pressure mains, except that their section is ·097 square inch, and their insulation is of a much less degree. Over the lead sheath they are yarned and strongly armoured by two ribbons of steel. They are then dressed with a special preservative material, and then yarned and passed through a bath of asphalte compound as a preservative. These cables are laid in the trenches along with the high-pressure pipes, and require no protection other than their own armour.

Low-pressure mains have been laid in the streets shown with black lines in them in Fig. 10, and it has already been found necessary to extend them beyond the original compulsory area into the residential district. The total quantity of low-pressure cable provided under the contract was 3,080 yards, and 2,418 yards in addition have already been laid, making over three miles in all. Arrangements are made on the low-tension side of the transformers for cross-connecting the mains so as to cut out the transformers in the event of an accident happening, and little, if any, inconvenience is caused to the consumers. The service lines leading into consumers' premises consist of cable of a similar make to the distributing mains, but of a smaller section, each conductor being ·035 square inch. The actual connection with the main is made by means of one of Callender's patent service boxes, Fig. 11, and the greatest

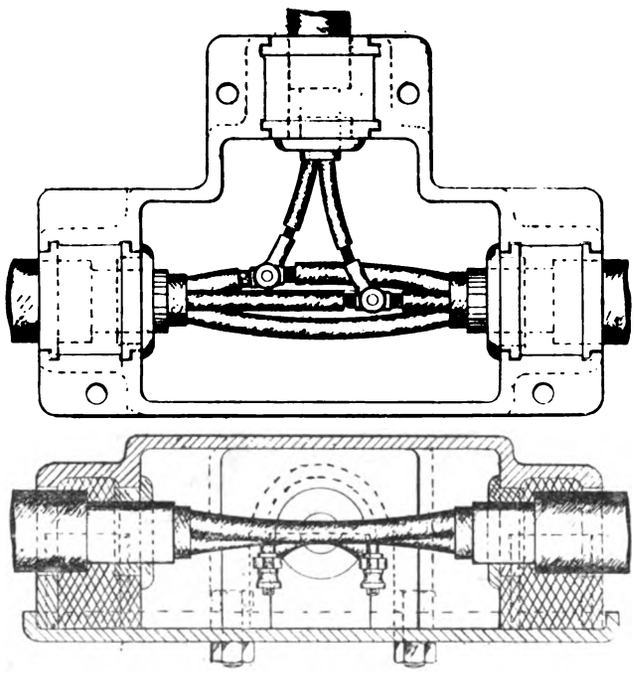

Fig. 11.—Callender's House Service Box.

possible care has been taken in making these connections. The service line ends inside the consumers' premises in one of Reid's patent fuse-boxes, which serves at the same time as a terminal box for the cable, and complies with all the requirements of the Board of Trade for the protection of consumers. There are at present 71 houses connected with the distributing mains, and applications are being received almost daily from would-be consumers. In addition to the private lighting thus provided for, there are 25 arc lamps in various parts of the town. They are connected by similar armoured Callender cable with the low-pressure mains.

The insulation of the cables has been most carefully attended to; that of the high-pressure feeders is over 5,000 megs per mile, and of the low pressure distributors 1,000 megs per mile. In addition to this, all the cables have been carefully tested with a pressure three times that which is to be used in actual working.

The transformers and transformer-boxes were supplied by Messrs. Swinburne and Co., of Teddington, and the arc lamps, posts, etc., by Messrs. J. Fowler and Co. The arc lamps are so constructed that the striking of the arc and the

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feed of the carbons are separately effected, although governed by one electromagnetic device, and through one mechanism. The feed is regulated by a detent and fan. The controlling device is a solenoid connected in series with the arc and a floating laminated iron core. The feeding mechanism consists of three wheels, forming a differential gearing, the striking acting on one wheel, while the feed acts on the other. An intermediate wheel connects the carbons to the striking wheel and also to the feeding wheel. Through this intermediate wheel the striking gear or the feeding gear can act positively on the carbons, but entirely independent of one another. In order to prevent any pumping when the current is first switched on, an air dashpot is used, which acts only during the striking of the arc, it being thrown out of gear when the feeding begins by means of slots in the connecting link between the core and the dashpot. The lamp is arranged to be self-focussing, so that the arc is always in the same position of the globe whatever length the carbon may be. The posts are of ornamental design, and have been manufactured by Messrs. Allen and Sons.

The gentlemen whose photographs we give herewith have taken active part in the work. When the proposal to light Ayr electrically was first mooted, Mr. James Smith was treasurer of the burgh and convener of the Lighting Committee of the Town Council, and in consequence of his holding the latter position the lion's share of the work naturally fell upon him. Although, as he readily confessed, without any definite knowledge of the work, Mr. Smith at once tackled the duty which was thrust upon him, and by persevering study and investigation soon became conversant with the details of the work projected. On Mr. Smith losing his seat on the Council at a recent election, Bailie Wm. Ure took up the work so ably commenced. Mr. Ure, being an engineer by profession, was able to give valuable advice to the committee when the station was being constructed.

The opening of these new electricity works will be performed on Wednesday, January 8, by Lord Kelvin, with due ceremony, and with the help of Provost H. D. Willock.

CABLE-REPAIRING—A TROPICAL REPAIR.

As the events I am about to relate took place in comparatively recent years, and most of the persons concerned are still living, I think it advisable, in the interest of those persons, to avoid unnecessary candour in the matter of names and localities. "Peace on earth and good will unto men."

The good ship "Express" had been beating her bows deep into southern seas for some months, robbing the bed of the sea of some of its wonderful carpeting and putting down in its place various lengths of brand-new cable, when orders were received to proceed at once to the coast of Bulamaroo to repair a total break which had occurred in the section between Caramba and Matahomo. To have to go to Bulamaroo at all was a misfortune. To make Caramba—a mixture of Muscat and Old Calabar—our headquarters, fell nothing short of a dire calamity. It was not the youngsters. They would have sailed for Guam with Jonah as a shipmate. It was parties with nerves—mainly the skipper.

Taking it generally, it was hard lines. The "Express" was a crack ship, commanded by a high-toned but nevertheless capable seaman. She—and he—had been accustomed to sail in civilised waters, and in the intervals between grappling with minor difficulties to be *fêted* and made much of by good society. The prospect of fever—when one has nerves—serves but to irritate, and the certainty of exchanging My Lords' graceful condescension for the offensive familiarity of a greasy negro population had little in it to soothe. However, we went.

It was, if I remember rightly, on the sixth day out that the Old Man took sick. On the twelfth there was no more champagne. At 11 o'clock that night I was on the upper bridge, tramping it for company with the officer of the watch, when a ghostly figure, clad in a long white garment, made its appearance at the telegraph, and, signalling "full speed astern" to the engine-room, shouted out "Breakers ahead."

It was the skipper, and he asserted that he could smell the land

Poor old chap. Now, I have nothing but pity for him—a gentleman, a first-class seaman, and, as a rule, a very abstemious man. It was due to an unfortunate and perhaps constitutional dread of fever that for the first and, I believe, the last time in his life he drank to excess. At that juncture, however, it seemed far more serious. We were upon an important mission, the latitude was one of frightful storms, and the thought that our lives were under the care of a man who smelt "breakers" when there were 700 fathoms of water beneath us and no land nearer than 500 miles was far from comforting. Eventually we got him to bed.

Arrived at Caramba, we proceeded to land our apparatus and take the necessary tests. The skipper was moderately sober but touchy. He intimated that he should consider it his duty to leave within 24 hours, whether we had located the fault or not, and declined to argue. Fortunately, the cable was brass-taped, and had been crushed flat so that it gave a dead earth, and the tests were simple and conclusive. We located a break 20 miles to the southward, and requested the skipper officially to take the ship to the spot indicated and place a mark buoy. For an hour or so we were busy with our preparations in the testing-room, and then my chief left to inspect the picking-up gear and the fore tank. It was at that moment that things became really lively. We were, it appears, steaming due north instead of due south, and when the skipper was remonstrated with he threw things—chiefly paper-weights — and used language equally hurtful. To put him under restraint was dangerously like mutiny on the high seas, but it had to be done, and with the chief officer in charge we again put into Caramba and telegraphed for instructions. What those instructions were I need not say, but the skipper never again resumed command.

The loss of so experienced a man as Captain ——— naturally made our work more difficult. My chief had to take charge of the deck, while I looked after the electrical arrangements and assisted in checking sights, etc. Not only was our chart wrong and the cable nine miles to the westward of the position laid down, but a submarine landslip had made 500 fathoms difference in the soundings, and, in short, we were all at sea. Of course, we found the cable at last—after breaking the toes off five grapnels—and then had to tear it out of a third of a mile of rock which lay on top of it, repeating the operation some two miles further south. For 36 or more hours we had not a scrap of food, a heavy ground swell made the ship roll her scuppers under water, and when, at five o'clock in the afternoon, we finished the final splice, and stood by to cut away and cheer, somebody said, "Good Lord, it's round the forestay!"

So it was.

It was in the nature of things as they happened that voyage that the skipper should turn up at the moment and witness our discomforture.

If ever a crew were in a blue funk, the crew of the "Express" could have gone one better. To unship a forestay with the ship labouring heavily is an experience. Every moment the foremast threatened to come by the board, but it did not, and by seven o'clock the final splice was safely slipped, and by half-past ten we knew that the repair had been successful. Our homeward trip was equally prolific of incident, but that is "another story."

Utilisation of Natural Gas.—The *Western Electrician* of December 21 describes an electric lighting and power plant put down for the supply of the buildings of the Franciscan Fathers at Oldenburg, Indiana. The peculiarity of the installation is that it is worked by a 25-h.p. Raymond gasoline engine designed to run either with natural gas or gasoline. There is a supply of natural gas from a well close to the building, but it is uncertain, and when it fails provision is made for falling back on gasoline. The dynamo is a Siemens and Halske, wound for 150 volts, and the field rheostat of the machine contains sufficient resistance to allow of running direct on the lights at 110 volts

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BEST WISHES FOR 1896.

"I held it ever
Virtue and knowledge were endowments greater
Than nobleness and riches: careless heirs
May the two latter darken and expend;
But immortality attends the former,
Making a man a god." Shakspeare.

The year just ended finished up with a brilliant display of war scares. Only one of these scares will concern us here, and that indirectly, inasmuch as it gave rise to certain ludicrous statements in the popular Press. Dalziel's correspondent must be a funny specimen of the *genus homo* ever seeking sensational "copy"—he really ought to be stuffed and put in a glass case in the British Museum as the champion disseminator of "believe-what-you-are-told information." Pour fluids into a sieve and they run through—the sieve has no discrimination, nor has this champion disburser of news. There is a war scare with America, and forthwith this brave champion rushes off on a Sunday, of all days in the week, to Edison to hear what Edison has got to say; and forthwith Edison proceeds to fill the investigator after sensationalism up to the brain with funny tales of the marvels he is going to do, and the newspaper man believes all he is told. *Punch* in its happiest vein could not fool so well. The fact is, this correspondent is either a fool or an ass. Well may the *Daily Graphic* have headed its note, "The American Munchausen." Besides the laughable side of this question, however, there is another. These sensational paragraphs do a real harm which it is impossible to eradicate, and in this direction the English popular Press is as much to blame for inserting such nonsense as the correspondent is to send it. Fancy any fool believing such utter rubbish as the following:

(1) "Water can be made more deadly than bullets. I have invented a machine by which it can be hurled to a great distance, and water charged with 5,000 volts and then dashed on an army would sweep it away like chaff. The only question is how far the water can be thrown?"

In reply to this, we say the statement which has been made before is all moonshine. In the first place, the water cannot be thrown any distance so as to retain its 5,000 volts, and if it could there is nothing more easy than to neutralise its effects. It is enough, however, to know that it is impossible.

(2) "I have also invented cables to be drawn around a besieged city which would deal death to anyone who tried to cross them; and so concealed that they cannot be discovered until too late."

This is bigger rubbish than the other. Edison does not know more about voltage, current, charge, etc., than thousands of other men, but he does know enough to be certain of the fallacy of such a statement. Again, even if he could do what he states, it is just as easy as cutting a piece of thread to stop all his dangers. Our attention has been called to a book which ought to be well known as coming from one of America's most talented and amusing writers—viz., Mark Twain—and if any reader cares to examine "A Yankee at the Court of King Arthur," he will find much of this electric fooling therein. Such a fact does not speak much

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for either newspaper correspondent, agency, or editor sending, receiving, and accepting fiction of this kind in sober earnest.

(3) "There are also electric chains to be fired into an advancing army. These are of different lengths, and are attached by one end to the wires of a dynamo while the other is placed in a cannon. When these are discharged the air will be filled with chains like great snakes, which would mean death to an advancing host."

Still going from bad to worse. We are inclined to ask this champion correspondent—or Munchausen—if he knows the velocity with which his chain gear would travel, and how he would arrange for his wire to be taken out at that velocity. We would like to know the section of his wire connection, and how he would save its insulation? We would like to know how he knows the other end of his chain will make a good earth connection, and if it did, or, if it did not, what would be the use of it? Are these chains to meander about the air at will? We do not see any danger to the advancing host, but we do see a very definite danger to any insane people who were to try the dodge. These ideas might do as specimens of Sinbad's methods of fighting, but we know a little too much of electricity and magnetism on this side to be terrified by this bold correspondent.

The other schemes mentioned are not electrical, so hardly concern us, but according to our lights have about the same value as those of an electrical character—that is, no value at all.

Up to the present we had credited Edison with a certain amount of genius, though we should not place him so high in the scale of inventors as some of his hero-worshippers do, nor should we place him so low as some of his detractors. If, however, he ever spoke the words attributed to him by this correspondent in any way but fun to stuff a silly man with tales to see how far he would believe them—that is, if he spoke in earnest—our standard of Edison's genius will be lowered to zero point.

It has been our good fortune lately to hear much of Edison, especially in praise of his phonograph. We agree that it is a beautiful piece of apparatus. This telegram of Dalziel's correspondent, however, has caused us to examine into the matter, and as a consequence we find that Edison *may* have obtained his inspiration for this invention from outside his own experiments. "There is nothing new under the sun," says the wise Solomon, and when we find *sound printing* or *phonography* described in 1843, and know how Edison and his collaborateurs ransack the world's literature for ideas, the hint *may* have come from an outside source. The following paragraph relates to the subject, and is of the date 1843:

"We now hear from Germany of the completion there of an invention which about three years since was stated to be in embryo in Manchester, the object of which is to impress the sounds of a speaker's voice on paper or other substance. We know not whether the foreign invention be the same as the Manchester one, but the accounts received of it appear very similar. It is well known that the vibrations communicated to the air by the voice communicate corresponding vibrations to elastic bodies at considerable distances, therefore it is not impossible that the various vibrations may be rendered visible, and made to leave permanent indications. Printing by sound, at all events, does not appear a more extraordinary performance now than painting by light would have appeared five years ago. The latter we have seen successfully accomplished, and we cannot deny that the former may be done. At present, however, we are not acquainted with the *modus operandi*, though we observe, from printed announcements, that a gentleman is about to deliver a lecture on the new art, called *Phonography*, when we may hope to be in possession of the means of taking the whole of a discussion, or of a lecture, home in our pockets for consideration or study at future opportunity. A reporter of this kind would be useful in Parliament, though even then it might sometimes be inconvenient to have the words printed exactly as they are spoken."

Before leaving this distasteful story we would recommend the correspondent referred to to study the following lines:

> "No! Science cannot leave her hill
> And shine with heavenly radiance still:
> Strive not to draw her from the skies,
> But to her bright meridian rise.
> Those who would nobler prospects view,
> And drink the living ether blue,
> Must boldly scale the mountain rude—
> The spell is in the altitude."

During these rumours of wars no doubt we shall hear something about electric guns. According to the following paragraph, the hail of bullets as from a Maxim or a Nordenfelt was achieved by an electric method also in the forties. Who was Mr. Beningfield? If this experiment was so successful, what became of the inventor and his gun? for surely it was in advance of anything else known in 1845. The period—50 years or so ago—is not too remote for someone still living to remember it.

"MR. BENINGFIELD'S ELECTRIC GUN.—Some very interesting experiments have been exhibited in a large plot of ground on the south side of King-street, Westminster, with an electric gun, the invention of Mr. Beningfield, of Jersey. The gun, a barrel for discharging bullets or balls $\frac{5}{8}$in. in diameter, is placed over the body of the machine by which the propelling power is generated, and the whole runs upon a carriage with a pair of wheels weighing altogether half a ton, and calculated to be drawn by one horse at the rate of eight or ten miles an hour: when in position, a third wheel is attached by which it traverses with ease and steadiness. The engineer is enabled to take a true aim, the barrel having a sight similar to a rifle. The barrel is supplied with balls from two chambers, the one fixed and the other movable. The last may be made large enough to contain an immense number of balls. It is calculated that 1,000 balls or more can be discharged in a minute, the volleys being shot in almost continuous or constant succession, the stationary chamber supplying the barrel. The experiments fully carried out all that the inventor professed to do. The bullets were driven through a thick plank, and afterwards completely flattened on an iron target. Those directed against the target without the intervention of the planking were literally beaten to atoms, and in a manner plastered upon boards placed on the sides of the target, which received the fragments as they flew off at angles from the iron. The force far exceeded what can be produced by any military engine of equal calibre in which gunpowder is employed as the propelling power. A 3in. board at 20 yards distance was completely shattered through with the bullets, as if the centre-bit and drill of a carpenter

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had been employed, and the rapidity and precision of aim was extraordinary. For clearing a breach or sweeping a force such an engine must be most tremendously destructive. The cost of keeping this gun in repair and of using it is stated to be very much beneath the cost which must be employed to bring into operation any other equally efficacious mode of discharging thousands of balls. The invention is not secured by patent, and therefore the inventor did not communicate the secret of the construction of his instrument or the nature of the power employed. It was avowed, however, that the propelling power is produced, not by steam, but by the application of gases exploded by galvanic electricity."

Men in those days were quite as energetic as men are in these days. Progress has been great in numbers, and hence in demand and volume of business, but they then looked ahead, even as we now look ahead. Telegraphs were few; this application of electricity was in its infancy. There were no cables, yet men discussed the time when the uttermost parts of the earth should be telegraphically connected. How soon after telegraphy was an actuality did the idea of cable communication commend itself to those interested we do not know, but it must have been in very early days. A paragraph in 1845 reads thus:

"A writer in the *New York Tribune* suggests a plan for bringing Old England within a speaking distance. He proposes to run a copper wire, well covered, and as large as a pipe stem, from Nova Scotia to the coast of Ireland. This, as is thought, may be accomplished by winding the wire upon reels, and arranging it on board a steamer so as to be reeled off as fast as the boat goes, and dropped the whole width of the Atlantic. The writer says: 'Its gravity would sink to the depth where water was so dense as to be of equal gravity, and, of course, beyond the reach of any kind of collision. Beginning and ending on a bold shore, beyond the reach of anchors, it would be out of harm's way, and exposed but to two kinds of accidents—viz., from separation by its own weight and the loss of the coating, from which the metal must be protected. The steamer "Great Britain" would carry more wire of this size than would extend to Europe, and its cost would, I think, be less than a million of dollars.'"

We might give a number of references to the capabilities of electric applications long anterior to these, but it would only show that we have what our forefathers hoped for, and this should lead us to infer that what we have will be superseded by our descendants.

Water Power.—Most of us get into a slovenly habit of writing, knowing perfectly well that only the few who are blind from the fact that they will not see are those who mistake what is written. Thus electricity is not electrical energy any more than mechanical energy is iron; but we are continually writing electricity for electrical energy, and nobody a whit the worse. Future controversialists and precise critics will no doubt quote sentences against us as evidence of lack of knowledge or precision; but that won't hurt us, and it may please them. We can never get over Thursday and Friday without being told of our weekly weakly sins. Then if we make a slip of a decimal or an adjective, our readers will have to generalise by using "about" as the result of the following calculation. The heat energy of the sun is the source from which we mostly draw our utilisable mechanical energies. Part of this heat energy is expended in vaporising and lifting water, and it is calculated that in a year 31,000 cubic miles of water are so vaporised, of which 13,000 cubic miles run back by rivers into the ocean. This water falls through a height equal to the mean level of the land, which may be taken for the whole world at about 1,000ft. The total water volume shed over England and Wales is about 20 cubic miles per annum, and we may assume the mean level of land at about 400ft. Thus in England and Wales 20 cubic miles of water fall 400ft. each year. A cubic foot of water weighs 62½lb., therefore a cubic mile of water will weigh 9,199,872,000,000lb., and falling 400ft. gives us 3,679,948,800,000,000 foot-pounds available from each cubic mile of water so falling. Then if 20 cubic miles so fall we have no less than 73,598,976,000,000,000 foot-pounds available, or about 2,230,272,000,000 h.p. per annum. Of course only a small fraction of this can be utilised, but for the sake of having the figures before us we have ventured to give what may be called the annual quantity of water on tap. It will be seen that a vast store of energy is now going to waste which will certainly be to some extent utilised when coal gets scarcer and therefore dearer.

THE ELECTRIC CONSTRUCTION COMPANY report an unprecedented amount of work during the past year. Enquiries and orders for all classes of machinery have been very numerous. Great progress has been made in the design and efficiency of their specialities in dynamos, motors, continuous-current transformers, alternators, and converters, arc lamps, switches, etc. No catalogues have been issued and better prices prevail. Among special contracts may be enumerated a supply of generating plant for the Corporations of Wolverhampton, Stafford, Manchester, and Halifax; the Liverpool, Birmingham, Chelsea, Oxford, Crystal Palace, and Clerkenwell Electric Supply Companies; Vestry of St. Pancras, etc. The Madras tramways have also been successfully put into operation. Work in hand includes 500-h.p. dynamo for the War Office, 300-kilowatt steam alternator for Halifax, motor equipments for the Liverpool Overhead Railway extension, the electrical equipment of Hartlepool tramways, and other important orders representing at least six months' work. The number of employés is steadily increasing, and important additions to the premises and machinery are being provided to cope with the great accession of business.

P. R. JACKSON AND CO. (Manchester) say that, although their new dynamo factory has only been in working order for about five months, they are full up with work, and have more than 30 dynamos in hand at the present time for customers. They have also a large electric hauling plant for a colliery and two electrically-driven centrifugal pumps, and complete electric plant for transmission of power in printing and bleaching works. The prospects for 1896 are extremely bright; there is not only every possible chance of being extremely busy in the electrical department, which they are arranging to extend, but they are extremely busy throughout the whole of the works, many machines, particularly the heavy machines, running night and day, Sunday included. The company say their new dynamos have been remarkably well received.

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RANSOMES, SIMS, AND JEFFERIES.—This firm report that they have been very busy during the past 12 months. Besides their standard engine and boiler trade, and other plants for electric lighting, a large business has been done by this firm in the "open-type" high-speed vertical engine, specially designed for driving dynamos, which they introduced rather more than two years ago. Messrs. Ransomes have had numerous repeat orders from early purchasers, and the engines have steadily progressed in the favour of electrical engineers and other users. The patent expansion-shaft governor, introduced by this firm about the same time as the engines, has given particular satisfaction on account of its absolute reliability and the extreme regularity of speed which it ensures. Messrs. Ransomes guarantee that the variation between full load and no load of an engine fitted with this governor shall not exceed 3 per cent., and they have figures taken by independent electricians showing a variation amounting to only half this. More than a dozen of the engines supplied during the past year have been fitted with the patent expansion-shaft governor, but in cases where the extra cost of this apparatus is objected to Messrs. Ransomes fit their engines with an improved governor acting upon a throttle-valve. In the design of this improved throttle-valve governor the objectionable governor driving belt is dispensed with, the governor weights being mounted directly upon the crank-shaft. Among the engines completed during the last 12 months, particular mention may be made of four compound vertical engines, with cylinders 11in. and 18in. diameter by 10in. stroke, revolutions 320, coupled direct to dynamos for large electric light installations in Scotland; a compound vertical engine, with cylinders 6½in. and 11in. diameter by 7in. stroke, revolutions 350, for driving the dynamo in connection with the Hermite deodorising process at the new Marsh sewage works of the Ipswich Corporation; and a double-cylinder vertical engine, with cylinders 11½in. diameter by 9in. stroke, revolutions 250, for electric lighting in a North Country cotton mill. A large number of small single-cylinder engines to be used in connection with ship-lighting plants have been supplied to various electrical contractors, and Messrs. Ransomes are now laying down three compound high-speed engines for driving part of their own factory. They have a considerable number of orders in hand, and prospects for the coming year are favourable.

THE EPSTEIN COMPANY.—The year 1895 has justified the expectations which the directors of the Epstein Electric Accumulator Company had entertained, based upon the steadily growing favour with which leading firms and many eminent electricians looked on these cells and the rapidly increasing demand for them owing to the unqualified satisfaction they had given in every instance. The new and splendidly equipped works at Milton, Staffs, were inaugurated towards the close of 1894, and manufacture on a much extended scale was commenced in January, 1895, and maintained without slackening off throughout the year. A goodly number of central stations has during that period been added to those who had installed Epstein batteries in previous years already, and many corporations and supply companies have rejuvenated their existing batteries of other types by replacing the worn-out parts with Epstein plates, a process for which these latter are specially well adapted. No less successful has this company been in securing the goodwill of many important firms of contractors in all parts of the United Kingdom, the Colonies, and abroad, the net result of the year's work being an increase of over 100 per cent. compared with the previous year. Such eminently satisfactory results are convincing proofs of the high reputation which Epstein accumulators have established for themselves. Developments in traction batteries of far-reaching importance and almost universal interest have now, after years of patient investigation and the most careful tests, reached that degree of perfection when they can be confidently supplied for the public service. While retaining all those parts liable to deterioration which during the past years have given so good an account of themselves, the entire weight of the cells has been reduced by no less than 70 per cent. To achieve this without affecting strength and durability has been a problem of great difficulty, yet, the company are glad to announce, it has found its solution at last, and it may be expected that the great and burning question of propulsion by means of batteries has entered into a practical stage.

THE ELECTRICAL COMPANY.—The Electrical Company, Limited, of 122 and 124, Charing Cross-road, W.C., have had a large share of the increased trade during the past year of development of the electrical industry. The special department opened by this firm about two years ago for the sale of dynamos and motors, and for the installation of transmission of power and lighting plants, has proved a perfect success, a large number of their machines having been installed all over the country and the Colonies, which are giving the fullest satisfaction. A point of great interest is that the Electrical Company, Limited, construct (contrary to the usual type of bipolar dynamos and motors) such machines only up to 100 amperes, of the well-known iron-clad type. Above 100 amperes for any output their dynamos and motors have four or more poles, the frame of these machines being also of one solid piece of steel. Thus the stray field is reduced to almost nil, with corresponding increase of efficiency. Owing to the great expansion of their business in this direction, the Electrical Company, Limited, have been compelled to make arrangements at their factory for doubling the output of machines, and they are therefore now in a position to ensure the most prompt delivery in the course of the New Year.

MELDRUM BROS. have fitted a large number of their furnaces to electric supply stations during the year. At Blackburn, six furnaces; Stafford, six furnaces; Newport (Mon.), eight furnaces; Bournemouth, seven large Babcock and Wilcox; Westminster, 10 furnaces; Islington, 10 furnaces. Some of these are also fitted with their patent silencing apparatus (as fully described and illustrated in our issue of October 11 last).

THE LIVERPOOL ELECTRIC SUPPLY COMPANY state that the number of lamps supplied from their stations during the year has increased to a total equivalent to 40,000 16-c.p. lamps. In addition to installations carried out by the company in connection with their supply system, they have completed contracts for numerous private installations, amongst which may be mentioned one of 500 lights for the Liverpool Rubber Company, Limited. The company are now engaged in lighting the Liverpool landing-stage for the Mersey Docks and Harbour Board.

JOHN SPENCER says that "during the past year we have been fairly busy with wrought-iron tubes used as underground conduits for wires and cables, also in socket and spigot pipes for the same purpose for various electric light and telephone companies.

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Several orders executed and in hand for large and small steam-mains for generating stations, together with the usual feed and exhaust pipes; also a moderate amount of orders for iron arc lamp poles, iron telegraph and telephone poles, both tapered and parallel, for use in connection with electrical mining work, tramway, telegraphic, telephonic, and fire-alarm systems. We have just put down an 'up-to-date' plant for best quality solid-drawn weldless steel tubes, of which we shall make a speciality, and we anticipate a big trade during the coming year."

ABERDEEN.—Mr. A. S. Blackman, the Corporation electrical engineer, writes: "The 'thorn in the flesh' of every central-station engineer is undoubtedly the often discussed but as yet never attained day load, and until matters are improved in this respect it can hardly be expected that anything very far in advance of present station costs will be achieved. Improvements in the matter of 'beating record' will no doubt appear from time to time as our station outputs grow; but for any radical improvement in costs, it is the day load we have to look to, and which seems a far more hopeful field than the small improvements we can reasonably expect to get in the way of increased efficiencies. In manufacturing towns supplied by the continuous-current system, and where there are numerous isolated plants, in factories, large hotels, etc., it has often occurred to the writer that great benefit would accrue to all parties concerned if supply companies and corporations would adopt a special low tariff for a day supply for the purpose of charging batteries on the large consumers' premises, and let those who wish take their supply during the daytime and store for themselves. I am aware that this is no new idea, and would not advocate it to in any way supersede the direct supply, but only to meet the requirements of large establishments who would otherwise lay down their own plant. Of course, these private batteries could be charged from the ordinary network, but the consumers' lamps would necessarily be of lower voltage than the supply, and the regulating cells might be paralleled for charging purposes. Very little skilled labour would be required by the consumer, and he would dispense with moving machinery. In the case of municipal undertakings, of course, we have electric tramways to look forward to, but in this we have the very awkward element of the two loads overlapping at the worst possible time, for the top-load period is probably the busiest time of the whole day with the tramways. It may be contended that the charging of private batteries is not likely to be a source of any very great profit to many undertakings, owing to the few isolated plants we have; but, on the other hand, there are many places where this would not apply. In Aberdeen, for instance, where we have turned out for the last year, roughly speaking, 160,000 units, had we also supplied all the private plants within reach, this output would have been nearly doubled, and the one half of our total output supplied during the daytime, with our present machinery and capital expenditure, or perhaps a very small addition to the latter for mains extension: and I have no doubt that Aberdeen is by no means an isolated case."

Telegraphic Extension in the Gulf of Aden.—The Berne *Journal Télégraphique* states that the French cable from Obock to Jibouti is now available for use by the public at a provisional tariff of 20 centimes a word. Jibouti is situated at the southern extremity of Tajura Bay.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE INSTITUTION OF ELECTRICAL ENGINEERS.

SIR,—If I rightly understand the feeling of the large section of members of the Institution who, with its best interests at heart, are of opinion that the time has now arrived when some changes should be carried into effect, their desires may be comprised under two principal heads.

They are anxious, firstly, that the constitution and the manner of election of the Council should be so altered as to render the Council more truly representative of those who are actually doing the electrical work of the present day, more in touch with their requirements, more conscious of their desires and aspirations, more amenable to their wishes; secondly, that the standard of qualification required for full membership of the Institution should be raised, so that such membership should be a real and not, as at present, a practically nominal distinction.

With a view to arriving at a satisfactory solution of these problems, I beg to submit for consideration the following suggestions, which are, of course, only in outline, and are capable in some cases of considerable modification in detail:

(1) Some curtailment of the growing preponderance of power at present vested in the permanent members of the Council as distinguished from the elective members.

(2) An increase in the number of elective members of Council so that all branches of the profession shall be more adequately represented.

(3) A large number of members of Council to retire annually so as to allow of the introduction of more fresh blood every year.

(4) Greater facilities to be given for country members serving on the Council, it being understood that such country members of Council need not give such constant attendance at the Council meetings as is expected of members resident in London.

(5) A much longer interval of time to elapse between the publication of the Council's nominations for new members of the Council and the date on which the ballot is held.

(6) The list of nominations to be published at least one month before the issue of the ballot papers.

(7) The ordinary members to be given an opportunity of adding names to the Council's nomination list, and names so added by ordinary members to be printed on the official ballot papers in such a manner as to be indistinguishable from those nominated by the Council.

(8) The evening devoted to the annual general meeting to be reserved entirely for the necessary formal business, and for discussion on any matters pertinent to the general affairs and welfare of the Institution.

(9) Some alterations to be made in the constitution of the Institution, whereby for the future no one shall be qualified for election as a full member who is not actively engaged as a practising electrical engineer or electrician, a new class being created—as in the case of the Institution of Civil Engineers—for those who desire to belong to the Institution, and whose association with the Institution may be of advantage to the latter, but who are not qualified for full membership.

None of the above suggestions can be said to be in any way revolutionary, one and all of them being taken from the regulations in force in other engineering societies older and more experienced than our own.

I believe that some changes in the direction indicated could not fail to be salutary, and would greatly increase the prestige, usefulness, and harmony of the Institution as a whole.—Yours, etc.,

A. A. C. SWINTON.

London, S.W., December 31, 1895.

SIR,—We are now going through a time which remotely resembles the agitation which has sprung up in the Transvaal, without, of course, the racial difficulties. A cure may be found in both cases by a large and liberal measure of reform.

Our constitution, it is said, does not provide for sufficient representation of the body politic. My competence to

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write on the subject may or may not lie in the fact that I am the survivor of the two founders of the Society of Telegraph Engineers, now the Institution of Electrical Engineers, and consequently the eldest (not the oldest) living member, having sat in the Council, either as a member, treasurer, or past-president, and been a constant attendant at its meetings since it first met in May, 1871.

As a member of the Institution, in which capacity I venture to address you, I am very much in accord with the general spirit of the various correspondents in the electrical journals—namely, that a radical alteration is necessary in the organisation of our representation. I believe we should not be afraid to cast ourselves free, if we find it necessary, from the shackles of tradition and custom inherited from other similar societies or institutions, and that there is plenty of scope for originality, the effect of which would be to bear useful fruit in welding together the interests of the various branches of the professions which form our constituency, thereby increasing the usefulness of the Institution, and giving it cohesion which will last for a long time to come.

The completion of 25 years of our life seems an appropriate time to have the subject exhaustively thrashed out, and I, personally, shall be most willing to aid any such movement that may be originated by a sufficient number of our members and associates, in order that, if necessary, our charter, which has been now in force for 11 or 12 years, may be altered to suit present and possible future requirements, which we understand far better now than we did even 12 years ago.

If I may be allowed to suggest, in spite of the too probable "pooh-poohs" of the conservative and "save-trouble" interests, the deliberations of any general committee appointed to consider the subject may with advantage deal with the possibility of the establishment of a "second chamber" in the governing body, which shall take a share separately and conjointly in dealing with many of the questions now dealt with by the existing Council alone.

I am myself in favour of local honorary secretaries and committees of members and associates throughout the United Kingdom; of larger and more effective representation of the great body of associates; and of limiting the use of the occasional vote of past-presidents who have practically given up attending the meetings of our governing body.—Yours, etc., C. E. WEBBER.

THE BLOCK TELEGRAPH SYSTEM.

BY J. PIGG.

The occasional occurrence of lamentable accidents, involving loss of life and destruction of property, on our railways reveals, under the rigid enquiries to which they are subjected, the fact that the system of block signalling on which we so implicitly rely is liable to break down under certain circumstances. Since the "block" system is entirely worked by electrical apparatus, an examination of some of the weak points in the system will not be out of place in the columns of a leading electrical journal, and a discussion of any points observed in practical working may result in suggestions for improvement.

It is a trite observation that when the cause of a failure has been ascertained half the remedy has been discovered, and it is therefore proposed in this article to show the most salient points as emphasised by recent events, and to point out as far as possible some remedies, having regard to the fact that improvements in this direction, as in most others, are necessarily the result of experience, and therefore of slow and gradual growth. The large amount of capital already sunk in the installation of signalling apparatus places an effectual check on revolutionary changes, to say nothing of the confusion inevitable from a total change in the methods of working.

Theoretically, the "block" system in use for working traffic on English railways is perfect. If by any means it is possible to preserve a distance, however small, between successive trains on the same line of rails, no disadvantage other than delay will follow. The primary function of all "block" working is to ensure the preservation of a certain distance, varying in different places, between two successive trains without unnecessary delay. This last condition is primarily dependent upon the arrangement of traffic, and may be dismissed from further consideration in connection with "block" working proper, which consists solely in passing trains safely through the different sections as they arrive.

The electrical apparatus provided in each "block" cabin has several functions, the chief of which are the indicating of the condition of the line, and the transference of signals indicating the description of the trains and asking and giving permission for these trains to pass through the section. There is not at present anything automatic in the general working of the "block" system—*i.e.*, the passage of trains through any section does not, *per se*, actuate any apparatus to protect itself, or indicate its presence to anyone concerned, and the electrical apparatus is therefore entirely dependent upon the actions of the signalmen being in accord with the actual state of the line. The actual passage of the trains is of course controlled by the outside mechanical signals worked by the signalman, but these are worked in accordance with the indications or signals received independently on the "block" instruments. The actual methods of signalling are too well known to require description.

An examination of the regulations, code of signals, and their order, together with the actual working of the instruments, shows that the important point in a "block" section is evidently considered to be at the receiving end—that is to say, that end of the section towards which the train is travelling. The signalman at the receiving end is responsible for the entrance of a train into the section by his acceptance of the "be ready" signal. He controls the indications of the "block" apparatus, and it is he who certifies that the whole of the train has passed under his protection by giving the "line clear" signal. Shortly stated, it may be said that every "block" section is controlled by the man at the receiving end, and that the man at the sending end acts simply as a more advantageously situated assistant or look-out man, and informs him when trains are ready to enter the section, but acts strictly on his instructions in allowing them to do so.

A closer examination into the methods of "block" working shows that it depends for its safety upon the absolute accuracy with which several men can perform their different duties. A slight dereliction or neglect of duty on the part of the driver of a train or the signalman at either end of the section may be followed by serious results. The driver MUST act in accordance with the mechanical signals exhibited. The signalman at the sending end of the section MUST exhibit such signals as are in accordance with the condition of the line as shown by the "block" instrument. The signalman at the receiving end MUST ascertain that the line is clear before giving permission for a train to proceed towards him. Instances are not rare where drivers HAVE run past signals at danger through fog or other causes; where a signalman HAS sent a train into a section without the necessary permission; and where a signalman has cleared the line and taken another train into the section without having first ascertained that the line was clear.

Hence it becomes advisable to consider whether, notwithstanding the degree of perfection of the system when properly worked, it is desirable to supplement the apparatus already in use in such a way as to minimise the chance of error on the part of those engaged in the work. That such checks are desirable there can be no reasonable doubt, and many suggestions of various kinds and different degrees of merit have been made with but meagre results up to the present so far as adoption for practical and continuous work is concerned.

The mechanical signals are of the greatest importance to railway working, but are of slight interest to electricians, except in so far as they are concerned in "repeating" them. Mechanical signals, however, are placed, or should be, in such positions as enable them to be seen by drivers for their guidance, and the practice of fixing signal on high posts, or at much greater elevations than the position of the drivers is, to be deprecated on account of the difficulty of seeing these signals in foggy weather. Any advantage gained by the signals being visible at a greater distance in clear

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weather is more than counterbalanced by the difficulty experienced in seeing the signals at all during fog, when the necessity for seeing them is much enhanced by the difficulty drivers experience in "localising" themselves. The system of fog signalling now in use is antiquated and expensive, and much valuable time may be lost in calling out and equipping men for this special and uncertain work. The ideal system of fog signalling is one that indicates, *on the engine*, that a signal which is being approached is at danger. Such indication should be visual and not aural, as at present, and it should be under the control of the driver, and be capable of being brought into use by him at any moment.

Any additions to the electrical apparatus in use for "block" working should conform to the following requirements: It should be cheap and simple, and not readily put out of order. It must involve no change in the character of the apparatus already in use, or give additional work to the signalman, and it must not interfere with the regulations of the service or the signals which it is necessary to send on the instruments for the working of the traffic. It must not be forgotten that the duties at the two ends of the section are by no means the same, or of the same importance, and that experience shows that apparatus designed for universal application or to serve a number of purposes nearly always fails to give complete satisfaction owing to its complexity. The apparatus devised should not, therefore, necessarily be all in one case—the simpler the duties of any instrument are the more likely it is to perform them efficiently.

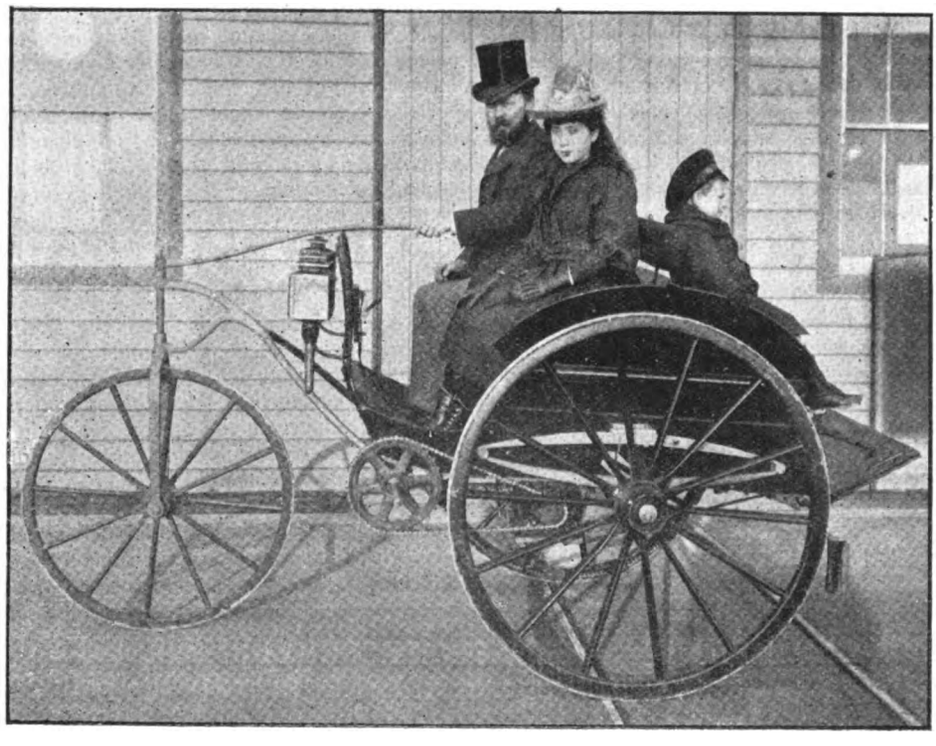
An apparatus which would appear to best fulfil the conditions required for the receiving end of the section would be such as would enable the "block" instruments to be locked in the "train on line" position, with the concurrence of both the signalmen, after the usual signals had been sent, the lock being so arranged that it would be released by the passage of the train over some point at the receiving end of the section. Such an arrangement would not be desirable as a means of "clearing" the line, but would be admirable as a check against the signalman performing this action before the train was actually in the proper position for him to do so. If neither signalman was able to clear the line until the train had passed a certain point near the receiving end of the section, where it must necessarily have passed under the eye of the signalman, then, with the exercise of judgment in selecting the point of release, such an accident as would result from a signalman clearing the line, and accepting another train from the rear, under the impression that the line was clear, could not occur. The danger of accidents occurring from this cause is not imaginary; such accidents have already happened, and there is not the slightest reason why, given an absent-minded man, they should not recur, more especially where the train standing is a short one and is at the "advance" signal.

It has already been pointed out that the chief danger arising at the sending end of the section, so far as the signalman is concerned, consists in his ability to send a train into the section, under misapprehension, contrary to the wishes of the man at the receiving end. The simplest method of preventing such a mistake would be to lock the "advance" signal by the "block" instrument for all positions of the latter except "line clear."

Such arrangements as those outlined in the barest possible manner would do much to enhance the safety of block working by providing valuable checks on the actions of those responsible for the working of the apparatus, and there seems no reason to suppose that suitable apparatus could not be provided at a reasonable cost.

MOTOR CARRIAGES.

As self-propelled vehicles are now receiving considerable attention, the time being near at hand when the present restrictions to their use on the public roads will be removed,



we give an illustration of a vehicle designed by Mr. Magnus Volk, of Brighton, propelled by a 2-h.p. motor. Although at the present moment electricity cannot compete with paraffin or benzoline when used to propel a road carriage, as far as regards distance, run, and cost, the electric carriage has a distinct field of its own, for there are always persons who are willing to pay a higher price if a better or more convenient article is to be obtained.

For runs up to 20 or 25 miles, for town and park use, the electrically-propelled vehicle is unrivalled. It is free from dirt, vibration, smell, and noise; is ready instantly, and can be used by ladies with the greatest comfort, and in these times the charging of the accumulators can be carried out with the greatest facility by attachment to the supply mains whilst standing in the coach-house.

Apropos of this, as accumulators could often be used for many purposes, an automatic charger that could be inserted in the main circuit so as to regulate the charging current, and automatically cut off when the cells are fully charged, would be a great desideratum. A proper number of cells would, of course, be used suitable for charging from the supply mains.

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TECHNICAL EDUCATION.

BY H. H. SIMMONS, A.I.E.E.

There are two fundamental questions regarding technical education which are most difficult to answer, and are consequently most vexed. The one is, What should be the duration of the purely theoretical training? and the other, When should this training be given? To give an arbitrary answer to either of these questions is surely impossible, for it must be affected both by the natural capabilities of the individual and the course he has mentally mapped out for himself. Apart, however, from such variable considerations as these, there are, it seems, two sides to both questions—that is to say, it is an open question how best to give a good all-round training to a man of average capabilities.

The ideal method is an elastic combination of theory and practice, including manual training, and such that it leaves the learner free to attack any difficulty which presents itself in either direction, care being taken to maintain the balance so that the bearing of practical on theoretical and theoretical on practical considerations be duly and simultaneously kept in view—an ideal almost impossible of attainment, except perhaps to the millionaire. This ideal is, however, hinted at, and an apologetic attempt to reach it is made in most technical colleges by the maintenance of a more or less sleepy workshop, where the machine tools are of an excellent kind, very much underworked and require little or no exercise of ingenuity or skill on the part of the operator. The expenditure on these shops is necessarily very large both in prime cost and upkeep, and it is hardly fair to look for improvements which would add largely to the cost of working.

It is, of course, out of the question to hope for manual skill of any high order from these shops, but they might surely be worked so as to be much more efficient in acquainting the students with ordinary workshop methods. Broadly speaking, one of three courses is now usually followed. College is made to follow immediately upon school, and the workshop or drawing office, or both, of some commercial undertaking supplies the further practical training without which no budding engineer begins to be worth his salt. Or this order is reversed; or, thirdly, pupilage supplies the practical and evening classes the theoretical training.

The second course is, perhaps, the best as a rule, for if a man be fit to become an engineer at all he cannot fail to observe and to seek the why and wherefore of what he sees, and this renders him peculiarly receptive toward the information subsequently to be gained at a college.

There is, however, a fourth method which must commend itself to all practical men, and which is being more and more largely followed—it is also a nearer approach to the ideal. On leaving school the youth of 17 or so enters a workshop as a boy at from 4s. to 6s. a week, and supplements this experience by evening study and technical training. In the workshop, workshop methods and current practice become familiar, while manual dexterity, not to be despised, though of very secondary importance, is also acquired: from private reading, theory may, in these days of innumerable books on every subject, be slowly but surely learned, but only at the cost, it is true, of patient, laborious study. Technical training, an entirely distinct thing, as has often been pointed out, can only be gained by attendance at some technical institute, or by years and years of painful and costly experience. It is this training which is needed to enable the engineer to combine theory and practice, and to truly estimate the relative importance of the considerations urged on either side for the solution of the problems he has to solve.

The advantage of this fourth course is that a widening range of acquaintance with both practical and theoretical considerations and their relative importance is acquired, and the risk of either's preponderating unduly is reduced, but against this must be set off the extremely hard work entailed, which requires a tireless patience and perseverance in spite of the slow apparent progress made. We are living, however, in an age of hard work, particularly of hard mental work, and the man whose constitution, whose funds, whose patience, and whose general education are sufficient, will find that this road will find him, broadly speaking, more competent, self-reliant, and generally better fit to take a responsible post than his brethren who have chosen the other roads, but he may have to wait till he is between 30 and 35 before his advantage becomes apparent.

ELECTRICITY IN MINING.

BY SYDNEY F. WALKER.

Enormous as have been the advances made in the development of electricity in every branch of business, probably in none has it been greater during the last 20 years than in mining.

It is now very nearly 20 years since the present writer took up the subject. At that time the telephone was not in existence, the electric light undreamt of for mines, and electric signals had a bad name. But the advent of the telephone in 1878 changed all that. Though the telephone in those days was correctly described as a scientific toy, the "boom" with which it was introduced created an interest in other electrical apparatus, and so electric signals again came to the fore. Now the number of mines in the kingdom in which they are not used is very small indeed, their great utility having long since commended them to the minds of mining engineers.

About this time, too, the electric light began also to make a fresh start. A few years before the writer had given up his position as electrician to the company who owned the Gramme patents, because the company had got itself into Chancery, and there seemed no chance of doing any work or getting any pay for it; but he had kept his eye constantly on the matter, and when the British Electric Light Company began to push the Gramme machine for electric lighting he arranged to work with them. About this time Mr. Hollingshead brought the "Lontin" apparatus over to the Gaiety Theatre, from which it was subsequently taken to the Gunner Colliery in the Rhondda Valley, but was not successful. Then appeared the "Brush" system, and immediately after the "Brockie" commutating lamp. In the latter part of 1879 and early part of 1880 the writer ran a temporary installation, consisting of two arc lamps and an A Gramme dynamo, at the Nunnery Colliery Company's coaling screens just outside Sheffield. This was followed by installations of five Brockie commutating arc lamps at the Gunner Colliery in the Rhondda, and at the Mardy Colliery in the Rhondda Fach valleys. These, he believes, were the first successful installations of electric lights at any colliery. At Cymmer the dynamo was driven by the workshop engine, at Mardy by the fan engine. The Cymmer lights were abandoned about two years later, and the colliery is still without electric light, one of the few remaining in the Rhondda. As there is an abundant supply of natural gas coming out of one of the pits which is cheaply adapted to illuminating purposes, immediately one of the periodic down waves in the coal trade appeared the electric light was given up. The Mardy dynamos worked on till quite recently, though the Brockie commutating lamps were abandoned as soon as the Sunbeam lamp became practicable.

Soon after this came the incandescent lamp. Risca Colliery, Monmouthshire, after its explosion, and Earnoche Colliery, in Scotland, adopted it at once, and almost simultaneously. At both, Gramme machines of the old A and B type were used, which have since been displaced. Risca still has the electric light, but has gone no farther. Earnoche has kept up its advanced position, and has now a hauling and pumping plant. Shortly after this the writer fixed a small plant of 40 lamps underground at Harris Navigation Colliery, the engine being driven by compressed air, this being the only method then available. The plant in a modified form is still working, as was also till very recently a plant which he fixed on the surface at the same colliery just previously.

After this time comes a period of continuous advance Colliery after colliery in all parts of the country have adopted the electric light, because it has been found to be cheaper, safer, and more convenient, even oil lamps not being able to compete with it. One plan is adopted in nearly every case. A dynamo and engine are placed on the bank in some convenient position, usually where another engine is at work, and cables are led from it to all parts of the colliery, above and below ground, often also to the houses of the colliery officials.

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The improvements effected in the dynamo since the expiration of the Gramme patent, the continuous education of colliery officials which has been constantly going on, and in which the writer claims to have had a large share, with the continuous improvement in the incandescent lamp, have all tended to effect this. The arc lamp has practically disappeared from mining work. The advent of the large incandescent lamp killed it. While the electric light in mines was still in a very infantile stage, Mr. B. Brain, at Trafalgar Colliery, in the Forest of Dean, had laid down a small electric pumping plant, consisting of an A Gramme series-wound dynamo as generator and a small Siemens series-wound dynamo as motor, and this plant continued to work until it was displaced by a larger plant a few years back. Years passed before other mines followed suit; and when it was taken up, it made progress very slowly. At first it was only used for dip workings, and is even now used more for that class of work than for any other. When the coal measures incline downwards from the shaft, as many do, much of the water present finds its way into the lower workings, and the electrically-driven pump, with its cables coiled on a drum, easily run out as the workings move forward, has proved very convenient and economical. Several large electric plants, pumping water from the neighbourhood of the pit bottom to the surface, have also been put down in various parts of the country. One such plant in particular, in Monmouthshire, is stated to have turned out very economical, the whole of the water now being got out of the colliery in a few hours, where previously three steam-pumps worked day and night to do the same. It is fair, however, in this case to mention that at least a portion of the economy effected is due to the system adopted of draining all the water into one large lodge-room, or tank, from which the electric pump lifts it to the surface. On the other hand, it is stated that compressed air could not have done the work satisfactorily; and in another somewhat similar case an eminent mining engineer told the writer that he had tested the efficiency of pumping by steam from the bottom of a shaft as against pumping by electric transmission, and he found that the loss by condensation more than overbalanced the losses by conversion and conduction in the electric system.

On a small scale, too, electricity is being used for drilling the flanges of steam-pipes, etc., the convenient electric drill being taken to the work, instead of its being necessary to take the work to the drill. It is also being used still, on a small scale, for directing currents of air through particular portions of the mine, a small electric motor, with fan attached, being easily and quickly placed in any required position. The writer believes that something of this kind would be very useful after explosions in mines, to direct currents of air easily and quickly in any direction that exploring parties may take. Within the last few years hauling and winding plants have been installed in a few mines in different parts of the country, and electric rock-drilling and coal-cutting machines have also been introduced into some of the Yorkshire collieries, and into some of the Cleveland iron ore mines.

Progress in all these is necessarily slow. Mine-owners are afraid that the sparks at the commutators of electric motors may fire gas. As it is now perfectly practicable to produce an electric motor that is not only theoretically sparkless, but that is absolutely sparkless under all conditions except those produced by extraordinary accidents, and as it has also been shown that the spark of the ordinary motor does not fire the gaseous mixture in a mine, there is every hope that these fears will gradually cease to be. The writer claims to have been one of the first to show, in a practical and scientific way, that nothing was to be feared from this cause; that it was not a spark *per se* which would ignite gas, but a spark of a certain energy—viz., about 20 watts. The writer's experiments were made with ordinary coal gas, but he understands that recent experiments by Prof. Vivian Lewes show the gaseous mixture met with in coal mines to be much less inflammable than ordinary coal gas. It is even claimed, on the authority of some experiments made in Germany, that the spark which passes between the broken ends of a live cable will not fire the gaseous mixture in a coal mine, as it does not continue for a sufficiently long period.

In the matter of the construction of cables for use with electric light and power currents in a mine, the writer is at variance with the general practice. His view is that it is unwise to protect the cable by an outer conductor, whether armour or lead, as you run great risk of damaging the insulation; that the money spent on the outer metal protector would be much more serviceably spent in indiarubber, the rubber itself being protected from mechanical injury by jute. Steel wires laid over the insulation render the cables difficult to handle, while they do not make them so strong that fracture is impossible. A striking instance of this came under the writer's notice a short time since. A pair of steel-armoured cables accidentally got on the tram-lines when a journey of coal-trams were passing. The cables were parted as by a knife.

It will thus be seen that electric transmission is now making steady progress, and is gradually pushing out both steam, compressed air, and rope driving, its rivals, and will probably continue to do so. No data have yet been published giving the actual cost of pumping, hauling, or coal-cutting by electricity. There should be plenty of materials now for comparing the cost of the electric pump with that of the steam, rope, and hydraulic pump. Moore's hydraulic pump, in which the ram consists of a long column of water, appears to be the most formidable rival the electric pump has to contend with at present. One of the principal difficulties that electrical haulage has had to contend with is the unequal strains brought to bear on the motor owing to the uneven nature of the roads over which the journeys of loaded coal-trams have to be hauled, and the increased tendency to sparking produced thereby. The most advanced proposal that has been made is that by Mr. Llewellyn Atkinson in a paper read before the South Wales Institute of Engineers a few months since. Mr. Atkinson suggests that in laying out new collieries, in place of having several engines in different parts of the colliery, doing various work, there shall be one or two large engines and dynamos fixed in some central position, and cables led to the different positions where work is required to be done, electric motors taking the place of the steam-engines now employed. Mr. Atkinson claims that the economy effected in this way at the centre will more than compensate for the losses of distribution and conversion. In the writer's opinion there can be little doubt that something of this kind will be the ultimate outcome, not only of colliery undertakings, but of many others, though how long it will be before this result is attained it is difficult to say. Already there are slight movements towards such a result. Some collieries already have a generating station from which electric currents are distributed for lighting, pumping, and hauling. As the education of the miner progresses, and as competition among collieries renders economy more and more needful, the plant will be more and more centralised, and no physical agent can compete with electricity where that is the end to be attained.

The prospects among mines at present are not bright. Colliery owners hesitate to spend money, even when future economies are clearly visible. The development of coalfields in various parts of the world is not only depriving coalowners of their markets, but is introducing competitors in other markets where they previously had none. Strikes in this country have given these competitors one opening after another, which they have rarely failed to take advantage of. Those who are closely connected with mines believe that electricity will be the salvation of the mine-owner. The difficulty at present is to make the mine-owner believe it too.

MESSRS. JOHNSON AND PHILLIPS'S TRIPLE-TANDEM WIRE-STRANDING MACHINE.

Owing to the great strides now being made in electric lighting and transmission, cable-making is becoming a most important industry, and we think, therefore, our illustration and description of a large wire-stranding machine which has just been completed by Messrs. Johnson and Phillips, of London and Charlton, will be of interest to many of our readers.

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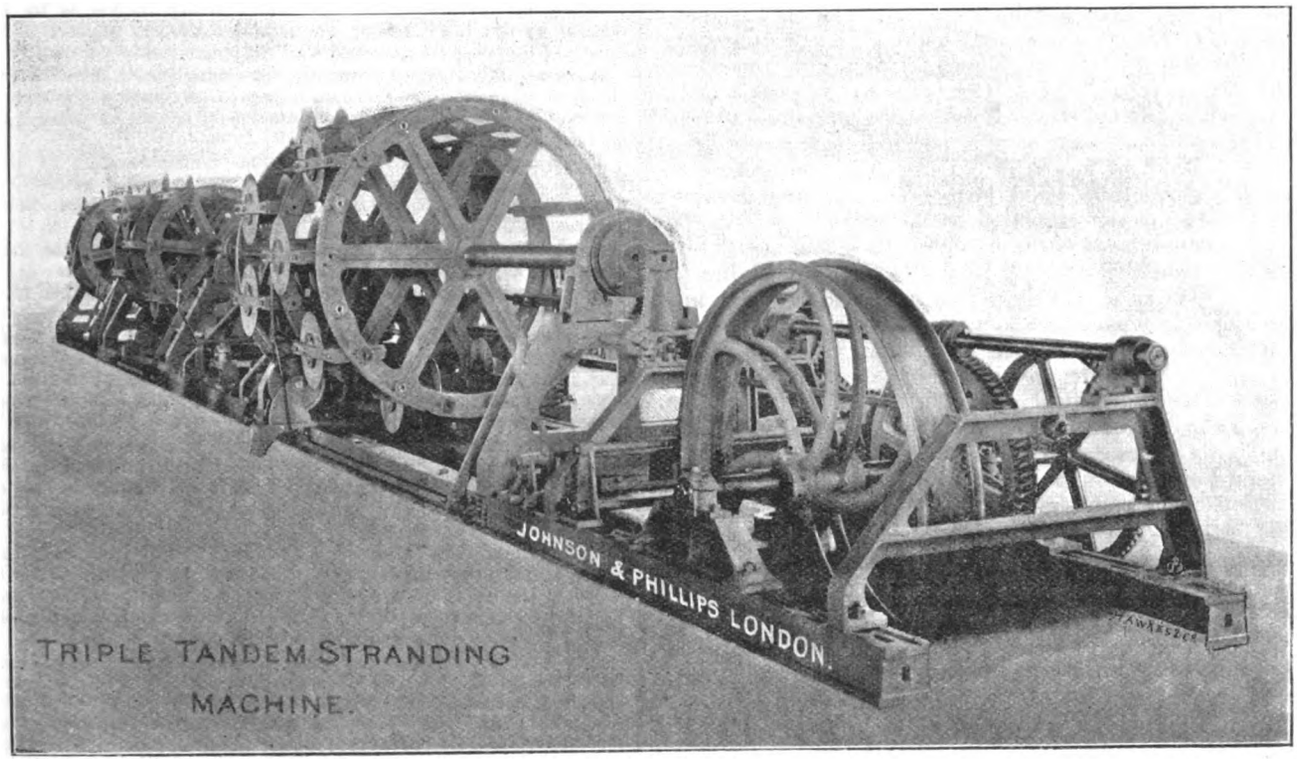
The machine in question, which has been built to the order of a large firm of wire manufacturers on the Continent, is what is termed a triple-tandem machine, and, as the name implies, consists really of three separate machines arranged "tandem." The first part is a six-wire machine, the second a 12-wire, and the third an 18-wire machine. Each part is arranged so that it may be run in the reverse direction to that of its neighbour, and at a different speed, and thus form a 37-wire cable in one operation. The centre wire being led through the centre hollow shaft, the first part of the machine lays six wires round it, forming a seven-wire cable; the second part lays 12 wires on this, forming a 19-wire cable; and the third part lays 18 wires over all, making up the 37 wires.

The machine will equally well make cables with a lesser number of single wires, or if a flexible cable is required, 37 strands made up of smaller wires could be used. The machine is also arranged that each part may be run in the same direction and at the same speed, and provision made for leading the wires from the first and second parts through the third, so that the whole of the 37 wires or any lesser number may be laid on a cable in one flake, as might be required in making a concentric cable. This also adapts the machine for making much larger cables.



For instance, if the 37-wire cable is passed through the machine again and covered with 24 wires a 61-wire cable is formed; this passed through again and covered with 30 wires forks a 91-wire cable, and this in turn can be passed through and covered with 36 wires, making up a cable of 127 wires. The bobbins each hold about 3cwt. of wire, and are suitable for all sizes up to No. 6 B.W.G.

All twist is kept out of the wires during the operation of cabling by means of the usual arrangement of cranks and eccentric rings. The ground space covered by the machine is 60ft. by 10ft., and it is erected on a continuous cast-iron girder bed running along its whole length. As will be seen on looking at the illustration, the draw drums are of large diameter, and they are driven by means of worm gearing, the speed being capable of considerable variation by means of change wheels to give the different lengths of "lay" for the wires.

The various parts of the machine are driven from a shaft running its whole length near the floor level. A novel feature in this machine is that the three sections are driven by chain gearing, and the builders believe this is the first example for a machine of this sort, and they claim that it is much quieter in working than the usual arrangement of spur-wheel gearing, the rattle of which causes so much annoyance. Another feature is that the central hollow shafts which carry the revolving part of the machine are provided at each end with heads which run on adjustable anti-friction rollers, and as the centre discs also run on similar rollers, the machine requires comparatively little power to drive it.

We understand that the machine is capable of making about three miles of cable per working day. Messrs. Johnson and Phillips have for some time been very busy in this department, and amongst other machines completed is one for the Postal Telegraphs for making seven-wire gutta-percha cables interlaid with yarns, and the whole covered with compounded tape, in one operation. We hope to give a description of this machine shortly.

ELECTRIC POWER PLANT AT THE CARTRIDGE FACTORY OF LUGANSK.

A correspondent sends us further information relating to this installation as follows:

The cartridge factory of Lugansk consists of 16 blocks of buildings, sufficiently distant from each other to reduce the gravity of accidents in case of explosion. These buildings contain five workshops, pump-chamber, central station, offices, powder and material stores, verification offices, stables, etc., and they cover a surface of nearly 30 hectares.

Under such circumstances, the distribution of power was rather a difficult matter with the usual system of mechanical transmission, the energy being produced by one engine only; on the other hand, the installation of an engine in everyone of the five centres requiring power would not have given an economical result, and, besides, it would have been necessary to place boilers within the buildings, which means an increase of the danger of explosion.

Electricity solved the question in a most satisfactory way, because it enabled a single central station to be placed in a separate building out of the radius of the others. The forge and the foundry being also placed at a distance from these buildings, and the shops being heated by steam, there is no fire whatever in the whole dangerous radius. The advantages of economy and facility resulting from the use of electricity are too well known to be again explained here, and we shall consequently only examine its applications in the factory of Lugansk.

Central Station.—There are in the central station five boilers, one of which will be a spare one, each of them having a heating surface of 2,480 square feet, producing

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steam at eight atmospheres for the heating of the works and feeding. An engine of Felser's system, triple expansion, of an output of 400 h.p. and running at a speed of 82 revolutions per minute, is coupled direct to a 120-volt continuous-current dynamo (H. Pieper's system), and shunt wound. The dynamo is of the flywheel type. A triple-expansion 200-h.p. Felser engine, running at a speed of 150 revolutions per minute, is coupled direct to a shunt-wound 120-volt continuous-current dynamo of H. Pieper's system. These two dynamos are connected to a main switchboard, where all the working of connecting and distributing is done. The 400-h.p. is used to do the power work and the 200-h.p. engine does the lighting, but each of them can (the apparatus being disposed accordingly) do the work of the other one. The tension is maintained constant on the switchboard by two automatic magnetic-field regulators.

There are 25 separate circuits from the switchboard for the 25 motors and nine circuits for the lighting.

Motors.—The big empty-cartridge and ball shop, under one roof, contains: two 40-h.p. motors, one 25-h.p. motor, three 16-h.p. motors, and three 6-h.p. motors, each driving separate shaftings for the chasing machines and for the drilling machines by means of belts; also two 3½-h.p. motors driving automatic lifts by pinion gear; one 3½-h.p. motor driving direct a Schiele ventilator and blast engine of the lead-melting furnaces; and a motor of ⅛ h.p., coupled direct to a fan which works the blow-pipes annealing the ends of the empty cartridges. A 12-h.p. motor is placed in the shop where the bullets are fixed, and where the automatic weighing of the cartridges is effected; this motor drives a countershaft by means of a belt. The shop where the machines are repaired and the tools manufactured is worked by two 10-h.p. motors placed on the ground floor and two 6-h.p. motors placed on the first floor; these four motors drive separate countershafts. A ⅙-h.p. motor is coupled direct to a forge ventilator, and there is a 6-h.p. motor in the forge driving a drop hammer and a ventilator. A 3½-h.p. motor, coupled direct to a Schiele ventilator, is placed in the foundry. The waterworks, situated at a distance of 550 metres from the central station, is worked by two 16-h.p. motors and two 8-h.p. motors, driving four Worthington pumps of a respective output of 454 and 227 gallons of water per minute, at an elevation of 72ft. with 23ft. suction. The pumps are belt driven.

Lighting.—The works are lighted up with 62 C. I. E. 10-ampere arc lamps and 1,000 16-c.p. incandescent lamps. In the dangerous buildings the cables, although insulated with okonite, are encased in tubes. The lamps are placed in protecting globes; the fuses and switches are placed outside the houses to avoid all danger of explosion. During the night the yards and the shops are lighted up with 100 incandescent lamps, fed by a battery of accumulators of 640 ampere-hours. This lighting is intended for the night watchmen.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Posen.—Tenders are invited by the State Railway Authorities for the supply of 90 000 carbon pencils Conditions for 50pfg. from Die Königl Eisenbahn-Direktion, Posen.

Ploesti —The Municipality of Ploesti invites tenders by January 15 for the lighting by electricity of the 46 principal streets in the centre of the town Conditions from La Mairie de Ploesti Roumania.

Brussels.—The Ministère de la Guerre invites tenders by January 15 for (1) a heating installation, (2) electric lighting in the new military school to be constructed in the Avenue de la Renaissance, Brussels.

Aussig.—The communal authorities propose to have built a seven-mile single line tramway. The choice of system is left open. Contractors are invited to place themselves in communication with the Stadtrath, Aussig a.-d.-Elbe, Prussia. Tenders are to be in by January 31.

Dublin.—Messrs Arnott and Co., Limited, Dublin, invite tenders from competent firms for electric light and power installation to their new premises, Henry-street and Princes-street, Dublin. A copy of specification can be obtained from Mr. George P. Beater, M R.I.A.I., architect, 17, Lower Sackville-street, Dublin, on payment of £5. 5s., which will be returned on receipt of bona fide tender, which must be delivered at architect's office on or before January 8, 1896, endorsed "Electric Installation, Arnott and Co., Limited.

St. Pancras (London).—The Vestry invite tenders for the wiring and other work in connection with the electric lighting of the Vestry Hall and offices in Pancras-road. Specification and conditions of contract can be obtained at the Electricity Department Offices, 57 Pratt-street, N.W., on payment of £1, which will be returned on receipt of a bona fide tender; and a plan of the general positions of the lights can be inspected at the office of the borough engineer at the Vestry Hall, Pancras-road. Tenders to be sent to Mr. Albert E Pycraft, chief clerk Electricity and Public Lighting Department, 57, Pratt-street, N.W., endorsed "Tender for Wiring Vestry Hall and Offices," by 12 noon on the 16th inst

RESULTS OF TENDERS.

Coventry —The tender (£140) of the Electrical Engineering Company Limited, for electric lighting installation at the free library has been recommended for adoption.

BUSINESS NOTES.

Bristol Tramways Company.—The receipts of this Company for last week showed an increase of £154

City of London Electric Lighting Company, Limited.—Warrants for interest have been posted on this Company's 5 per cent. debenture stock.

Islington (London).—The electric lighting station is to be opened by the Lord Mayor, accompanied by the sheriffs. The date will probably be February 27.

Hornsey (Middlesex).—The District Council have decided that the application of an engineer in reference to lighting the streets and buildings in the district with electricity cannot at present be entertained.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 29 amounted to £941, as compared with £837 in the corresponding week of 1894 being an increase of £104.

Bradford.—In view of the extension of the Corporation electricity works, which will shortly become necessary, the members of the Electricity Sub-Committee are making visits to other electricity generating works

Peterborough.—The borough engineer reported to the Town Council that he received a communication from Dr. Fleming stating that the current for arc lamps must be supplied from a separate circuit, and an estimate for street-lighting on this system is being prepared.

Johannesburg (Transvaal).—A Reuter's telegram in the *Times* states that the conditions of the Government contract for the establishment of electric lighting in the town forbid the use of English-made plant, and provide that only that made on the Continent is to be adopted.

Rotherham.—The Electric Light and Tramways Committee have decided to recommend that the town clerk be instructed to lodge a petition in opposition to the Sheffield District and Rotherham Tramways Bill. It was also recommended that application be made for a provisional order for electric lighting

City and South London Railway.—The returns for the week ended December 29 were £890, compared with £858 for the corresponding period of 1894, being an increase of £32. The total receipts for the half-year 1895 were £23,443, compared with £23,305 for the corresponding period of 1894, being an increase of £138.

Calendar for 1896.—The Chloride Electrical Storage Syndicate, Limited, have sent us a very attractive calendar in a neat frame. The dates are given clearly Some half dozen different types of accumulators manufactured by this firm are illustrated on the calendar. We note particularly the cell designed for traction purposes.

Western and Brazilian Telegraph Company, Limited.—The directors have received telegraphic advice to the effect that the necessary authorisation for the purchase of the Company's line had been continued by the Brazilian Chamber of Deputies and the Senate, and was included in the budget for the ensuing year. The receipts of the Company for the past week were £2,329

Trade Review.—We have received Messrs Bolling and Lowe's "Trade Review" for the year. "Electricity," this circular remarks, "is coming more and more to the fore as an actual factor in our daily life both for lighting purposes and motive power. There is good reason to believe that those experts are right who say, to use a popular phrase, that it is only in its infancy"

Newmarket.—After a week's consideration, the Urban District Council have resolved to object to the provisional order of the Newmarket Electric Light Company on the ground that as a drainage scheme was shortly to be considered for the enlarged area of the urban district, the steam machinery necessary for that might also be utilised by the Council for the supply of electric light to the district

Blotting Pad.—We have received from the Electrical Power Storage Company, Limited, a most useful blotting pad almanac and diary for 1896. The information contained in the beginning of the diary is of great service to all electrical engineers, and the

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indexed diary forms a pleasing addition to this blotting pad, which has now become an established adjunct to the office furniture of an electrical engineer.

Salt Chemicals Syndicate, Limited.—This Company has been registered with a capital of £5,000 in £1 shares. Its objects are to acquire any patents, inventions, etc., relating to improved methods of producing caustic soda by electrolysis, or other kindred methods, and to develop and work the same. The first directors are to be elected by the signatories, and no qualification or remuneration is specified.

Aberdeen.—It has been reported at a meeting of the Gas and Electric Lighting Committee that the Secretary of State for Scotland had sanctioned further borrowing powers in respect of the electric lighting undertaking in the city. The committee have resolved to fit up shafting in the Corporation gas-stove depôt in Union-buildings, and to invite makers to send various kinds of electric motors for exhibition.

Chelmsford.—The committee of the Arc Works Relief Fund having met, Mr. H. C. Hawkins, who attended on behalf of Messrs. Crompton and Co., stated that practically all the men were at work again. It is probable that no further relief will be needed, but it was decided to hold over the £100 subscribed by Messrs. Crompton and Co , and four other sums, and the meeting was adjourned for a fortnight.

Madeira Electric Lighting Company, Limited.—This Company has been registered by Mr. R J. Twyford, 44, Finsbury-pavement, E.C., with a capital of £20,000 in £1 shares Its object is to enter into a certain agreement with Messrs. Ullathorne and Hartley for the acquisition of a concession to supply the city of Funchal with electricity for light, power, or other purposes The directors are to be elected by the signatories

Houghton Main Colliery (Yorks).—The electric lighting plant which has just been installed for the management by Messrs Crompton and Co. consists of six large arc lamps, four of which are 15-ampere, 3,000 c p. two 10-ampere, 2 000 c p , and 200 incandescents, with a dynamo giving an output of 240 amperes at 110 volts. The dynamo is driven by an engine of the ordinary horizontal type, giving about 40 h.p

J. C. Howell, Limited.—This Company was registered December 20 by Messrs Deacon and Co., 9 Great St Helens, E C., with a capital of £10,000 in £1 shares. The Company is to acquire all the property of the firm of J. C. Howell, and intends to carry on business as producers of and suppliers of electricity for the purposes of light, heat, power, etc. Mr. John C. Howell is to be sole managing director, his remuneration as such being £800 per annum.

Lockwood's Builders' Price-Book.—We have received from Messrs. Crosby Lockwood and Son, 7, Stationers' Hall court E.C., a copy of this book for 1896. About 30 pages are devoted to electric lighting prices, and the general conditions of supply of the City of London Electric Lighting Company are given as illustrating what the architect and builder have to provide for. In addition to this, the Phœnix Office Rules are added in full in an appendix.

Seamless Copper Steam-Pipes.—We are informed that the Marine Department of the Board of Trade have completed an exhaustive series of tests upon electrolytically formed seamless copper steam-pipes made by Elmore's Patent Copper Depositing Company, Limited, Leeds, and as a result the Board's inspectors have been instructed to pass this company's steam-pipes for use in passenger and other steamships built under Board of Trade survey.

Scotland and Electricity.—It has been noted that, while in England parliamentary powers are to be sought during 1896 by quite a number of municipalities and companies for the construction of electric tramways, from Scotland no such applications are announced. A similar large number of notices of applications for parliamentary powers for the supply of electric lighting have been lodged by English towns, while not a single application has been made from any town in Scotland.

Fareham.—The poll of the parish on the question of purchasing the undertaking of the Fareham Electric Lighting Company or the paying of the damages (£3,800) awarded in the recent lawsuit for nonfulfilment of contract has taken place. Contrary to expectation, the poll was not a heavy one, more than one-half of the electors not voting. The result was: for the purchase of the works, 431; payment of damages, 235—majority, 196 There were 16 spoilt or unmarked papers.

Dublin.—The burgesses' meeting to consider the Corporation Improvement Bill is fixed for February 5. At this meeting the burgesses will also be asked to pronounce upon the schemes embodied in the Rathmines, Dundrum and Blackrock District Tramways Company's Bill; the Dublin United Tramways Company's Bill; and the Dublin Southern District Tramways Company's Bill The executive of the Dublin Trades Council have issued a circular recommending that the scheme of the Southern District Company should be supported.

Wimbledon.—The Urban District Council have received a letter from the Local Government Board, stating, with reference to the Council's application to borrow £32,000 for the purposes of electric lighting, that in view of the early expiration of the electric lighting license of 1889, the Board would not be in a position to sanction the loan for any period longer than the unexpired term of that license. The chairman and clerk were appointed to wait upon the secretary of the Local Government Board. Wimbledon, with a population of 34,000, is at present lighted by means of paraffin lamps.

Kamm's Zerograph Syndicate, Limited.—This Company has been registered by Messrs. Osborn and Osborn, Exchange-chambers, Copthall avenue, E.C., with a capital of £12,000 in £10 shares. Its object is to enter into an agreement with L Kamm, and to carry on business as manufacturers of and dealers in telegraphic apparatus, or any other apparatus to be used for the transmission of messages. The directors are S. Reuschel and L. Kamm. The qualification is £100. Remuneration, £100, divisible; and the registered office 133 and 135, Old-street, E.C.

Tunbridge Wells.—The Lighting Committee have resolved that the thanks of the committee be given to the electrical engineer for the manner in which he carried out the arrangements in connection with the recent electrical exhibition, and that he be given a gratuity of £10. 10s from the exhibition fund for his services. It was also resolved that gratuities be given to the subordinate staff. On the discussion of the report of the Lighting Committee in the Town Council complaint was made of the neglect to light the side streets at night, and Mr Boot, the electrical engineer, explained that new machinery would soon be ready at the central works to meet extensions and the promised full 24 hours' pressure.

Elmore's Wire Manufacturing Company, Limited.—At the annual meeting of this Company, held in Leeds, the chairman (Mr. J. J. Atkinson) explained a financial arrangement whereby the Company would start the new year unencumbered by any old losses. He said the Company's sales had steadily improved since the beginning of 1895, when the sales of copper sheets were only a few tons monthly. Now further progress was only stopped by shortness of capital. In a short time a scheme would be propounded for largely increasing the Company's resources to meet the demand for high-class and higher-priced products. It has been decided to issue £7,000 worth of 6 per cent. debentures, more than half of which have been already applied for.

Sheffield.—The condition of the tramways question is at present as follows: The statutory town's meeting has been held to approve the Corporation's Bills for the working of the tramways of the city. The present company—the Sheffield Tramways Company—are applying for a renewal of their lease, and a new company—the Sheffield and District Tramways Company—have given notice of their intention to apply for powers to acquire the present system and to make numerous new lines all over the city, the new system to be worked by electricity. The town's meeting approved the decision of the Council to promote their Bill, and also consented to opposition to the applications of the two companies. At an informal meeting which followed, the Council were requested to apply for a provisional order so that in case they obtain possession of the tramways they may proceed with extensions at once. The Rotherham Corporation have also decided to oppose the Sheffield and District Company's Bill.

Glasgow.—Satisfactory reports are to hand concerning the working of the electrical power distribution plant put down a few months ago at the ironfoundry of Messrs. R. Maclaren and Co. Here a gas engine of 180 h p , supplied from gas from a producer, drives a dynamo from which an electric current is distributed to motors in various parts of the works. These motors vary in power from 3 h.p. each to 25 h.p. each, and the coal consumption is stated to be about 1¼lb of anthracite coal per hour per actual horse-power delivered by the motors at the points required. Sheriff Guthrie has given judgment in an action by the National Telephone Company, Limited, against Hugh Wilkie, watchmaker, Glasgow, for recovery of a year's rent for an instrument supplied by them to Wilkie From the evidence it appeared that Wilkie was somewhat deaf, but the Sheriff found that it was an implied condition of the contract that the telephone was to be made suitable to his special case, and that this was not done, despite repeated complaints. He therefore gave judgment for the defendant with costs.

Edinburgh.—At a meeting of a sub committee of the Lord Provost's Committee of the Town Council, a letter of the manager of the National Telephone Company suggesting that the Corporation should lay down underground tubes for telephone wires at the expense of the company was considered, and the sub-committee resolved to recommend that the proposals made by the Telephone Company should not be entertained. The Electric Light Committee have resolved to recommend that the following streets should be lighted by electricity: (1) from the Literary Institute to Salisbury-place, eight lamps, at a cost of £144; (2) from Waterloo-place to Abbeyhill, 16 lamps, at a cost of £288; (3) from Lauriston to Tollcross, 14 lamps at a cost of £252; (4) Dalry-road from Haymarket to Ardmillan-terrace, 20 lamps, at a cost of £360; (5) Fountainbridge from Freer-street to Viewforth, eight lamps, at a cost of £144; (6) Greenside to Pilrig, 25 lamps, at a cost of £450; (7) Frederick-street to Comely Bank, 18 lamps, at a cost of £324; (8) Hanover-street to Canonmills, 20 lamps, at a cost of £360; (9) Cowgate from the Grassmarket to St. Mary-street, 14 lamps, at a cost of £306.

Direct Electro-Generator Syndicate, Limited.—This Company was registered December 20 by Ashurst, Morris, Crisp, and Co., 17, Throgmorton avenue, E.C., with a capital of £100,000, divided into 100 000 shares of £1 each Its object is to adopt and carry into effect (with such modifications, if any, as may be agreed upon) an agreement expressed to be made between Charles P. Shrewsbury, John Cooper, Frank L. Marshall, and John L. Dobell of the one part and the Company of the other part, the said agreement being referred to in Clause 3 of the Company's articles of association, and generally to carry on, in all or any of their respective branches the businesses of electricians, generators, and suppliers of electricity, mechanical engineers, and manufacturers of and dealers in all apparatus and things required for or capable

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of being used in connection with the generation, distribution, supply, accumulation, and employment of electrical energy. The signatories are: A. J. Seton, 36, Buckingham-terrace, Edinburgh; H. Dobbin, 4, Balmuir-terrace, Putney; S Spill, 24, St. Ann's-villas, Royal-crescent, W.; J. Cooper, 8, Furnival's inn, E.C.; F. L. Marshall, 22, Streatham-hill, S.W.; J. Lindsay, 32, Lupus-street, Pimlico S.W.; E Hills, 11, Paulton street, Chelsea. The first directors—of whom there shall not be less than three nor more than 10—are Major A. D Seton, Charles P. Shrewsbury, of Glyn Neath, Glamorganshire, Harry Dobbin, John Cooper, and Frank L. Marshall. Qualification, £250, and their remuneration is to be fixed by the Company.

Colchester.—The Town Council in committee presented a report, in which they stated that they had adopted a special report presented by the Lighting Committee, which had been to the effect that an important communication having been received from the officer commanding the Royal Engineers in the Eastern District in reference to the lighting of certain military premises, the Lighting Committee, in view of the letter from the War Department, and that a reply was evidently urgently required, recommended that the provisional order be put into operation, and that they be directed to take the following-mentioned proceedings on behalf of the Council—viz: Arrange terms with Mr. Massey, or other technical expert, to prepare a scheme, with specification and plans, on which tenders could be invited from firms of electrical engineers of good standing. Enter into provisional agreements with owners of suitable land on which works might be erected, and obtain plans, specifications, and tenders for the requisite buildings. Prepare particulars for the Local Government Board, with a view to application being made for their sanction to the borrowing of the sum required, and make provisional arrangements with the War Department for the supply of electric light, and report to the Council when these matters have been attended to, and obtain further instructions. On the motion, however, for the confirmation of the report, an amendment was carried adjourning the matter for a fortnight for further information.

Lightning Express Railway Syndicate, Limited.—This Company was registered December 23 by Messrs. Lindo and Co., 2 and 3, West-street, Finsbury-circus. E C, with a capital of £100 000 in £1 shares, 25,000 of which are 10 per cent. cumulative preference. The object is to acquire all the inventions now the property of Mr. Fritz B. Behr, of 6, Old Jewry, E C., in connection with lightning express or high speed railways, and in connection with improvements in carriages and electric locomotives for such railways and the sole and exclusive license to use the inventions belonging to the Lartigue Railway Construction Company, Limited, for the purpose of building, equipping, and working lightning expresses or high-speed railways. With a view to the above object the Company will adopt and carry into effect an agreement to be made with Mr. Fritz B. Behr. and generally carry on business as constructors of railways and tramways of every description, and in particular of those of a single rail on the Lartigue system of construction, and also as mechanical and electrical engineers, shipowners, carriers, and the business of a telegraph, telephone, and electric light company. The signatories are: L Clow, 22, Austinfriars, E.C; C. G Lindo, 2 and 3, West-street, Finsbury-circus; S F, Foster, 48, Victoria-road, Kensington; B G. Lake, The Priory, Orpington Kent; F. B. Behr, 6, Old Jewry, E C.; A. J. Sanderson, 66, St. James's-street, Pall-mall; N. S Russell, 39, Coleman-street, E C.; and the first directors—of whom there shall not be less than three nor more than seven—are to be elected by the signatories. The qualification is £100, and the remuneration £1 000 per annum for the first two years, after which as the Company may decide.

Swansea.—The Town Council, after hearing the adverse arguments of a deputation headed by Dr. Griffiths, have decided at their statutory meeting, by a majority of 30 votes to 7, in favour of prosecuting in the next session of Parliament the triple scheme for electric lighting and tramways and a dust destructor. Mr. R. Martin, chairman of the committee, in moving the formal resolution empowering the Corporation to proceed with its Bill, said the tramlines of the town were at present in a sad state, but under this arrangement they would be renewed, and the company enabled to run their cars at a profit. By getting the tramways company as a customer for their "day load" the Council would be enabled to sell electrical power for lighting at, not 6d. per unit, as had been suggested, but at 3d., and still leave a profit. Even assuming that they had to burn coal to generate the power, the total cost, including sinking fund, would be only £5,879 a year. That being so, could anyone doubt their ability to dispose of electricity at 3d. per unit—a price which meant something like 1s. 6d. per 1,000 for gas; 275,000 units at that price would mean £7,503. 16s. 8d, leaving a profit of £1,695 a year to go towards reduction of the rates of the borough. Mr. Martin went at length into the arguments in favour of the scheme, and said the result would be that the street-lighting would be done for nothing, and surplus power could be disposed of at 3d per unit. They had not pinned their faith on the destructor. As a matter of fact, it was absolutely necessary that a new method of disposing of town refuse should be adopted. This was the best means of destroying the refuse, and whatever heat could be obtained from it should be applied to the benefit and relief of the ratepayers of Swansea. In spite of the large majority on the Council there is influential opposition to the scheme, and it has still to be passed by a town's meeting.

South Staffordshire Tramways.—As the result of negotiations conducted by the Streets Committee of the Walsall Town Council, the Electric Construction Company have agreed to continue to run the electric tramcars on the present terms until the end of January. In the meantime the Mayor of Walsall will use his good offices in endeavouring to effect a more permanent arrangement. So far as concerns the portion of the tramlines worked by steam, the company have received permission from the Board of Trade to continue to use steam traction until March 25. Mr. Henry Hatchett, the secretary of the company, has been interviewed, and in reply to a question whether the company would consider the advisability of adopting some other means of traction between now and the expiration of the certificate, he said that the directors had already had the matter under their consideration. Speaking on the question of the cable system, he said he did not think their traffic would warrant its adoption In the first place, the initial outlay was very costly, whilst to make it pay a five minutes' service of cars was necessary. Again, the laying down of the cable would necessitate a suspension of the tram traffic, and would, he thought, constitute a considerable annoyance to the shopkeepers and residents on the lines of route. On the other hand, the overhead electric system, such as was at present working successfully in Walsall and part of Wednesbury, would not interfere with the present tram traffic; indeed, he said that the steam trams could run up to the very day of the adoption of the overhead electric system. The alteration of the system, was, however, a matter which called for very careful consideration, for the company at present possessed no fewer than 36 engines. How seriously the suspension of the running would have affected the public may be judged from the fact that the company during the course of a year carry passengers to the number of ten or eleven times the entire population of the various districts traversed by the steam trams.

Newcastle-on-Tyne.—The British Thomson-Houston Company, Limited, of London, have made an offer to work the trams of Newcastle by electricity, and in order to bring the matter before the Corporation have sent a circular to the town clerk and to every member of the Council asking the Council to hesitate before finally committing itself to the cable system. The company offer to provide a generating station with car sheds and engineering and repairing shops on land provided by the Corporation, and to relay the whole of the lines proposed to be equipped for cable traction, the trolley wire to be carried overhead on steel posts in a manner similar to that employed at Dublin and Bristol, and the whole of the work to be carried out at a cost not exceeding £86,000. They state that they are prepared to take a lease from the Corporation for 7, 14, or 21 years upon the terms that they (the company) supply at their own cost the requisite rolling-stock, consisting of cars carrying 43 passengers, and also, if necessary, double deck trail cars for use at times of exceptional pressure. They further agree to work the lines as to fares, times, and workmen's cars in accordance with the proposals embodied in the report of the Town Improvement Committee, with the addition of the running of a Sunday service if necessary. By way of rental they offer to pay 7 per cent. on the total sum to be arrived at by adding the cost and interest of the reconstruction, half the cost of widening Byker Bridge, and the proportion of the old debt applicable to this portion of the tramways (less the value of the old materials) and 3 per cent. on the value of the land. A half-yearly account of profit and loss would be issued, and of the net profits therein shown, 15 per cent. to be payable to the Corporation. The circular states that this will probably result in an annual profit to the Corporation in relief of rates of something like £1,200 to start with, which would grow with the increase of the city and the prosperity of the undertaking without any risk to the Corporation. In conclusion, the company say the work of reconstruction could be carried out in from six to nine months, but during the period little interference need take place with the existing horse traffic working. Correspondence on the subject still continues in the local Press, the tone being decidedly adverse to the decision of the Town Council in favour of cable tramways. The Newcastle-upon-Tyne Electric Lighting Company have just ordered from the Brush Electrical Engineering Company a 300-kilowatt Mordey alternator, making the sixth machine in this station, and bringing the total capacity of the station up to 900 kilowatts.

Wycombe (Bucks).—The Electric Lighting Committee having reported in favour of the Town Council entering into a contract with Messrs. Pritchetts and Gold for the electric lighting of the town, it was unanimously resolved to empower the committee to arrange the details of the contract. A subsequent motion to obtain the advice of an expert was lost, and it was also decided to give six months' notice to the gas company to terminate the present lighting contract. According to the arrangement with Messrs. Pritchetts and Gold, who will take over the Council's provisional order, the price for public lighting is to be £3 per annum per 16-c.p. lamp, the hours of lighting and other conditions to be similar to those in the present contract with the gas company, and the contract is to be for a term of 10 years. Electricity is to be supplied to private customers by meter at the rate of 8d. per Board of Trade unit, and the Corporation is to undertake to take a supply at the above rate for all municipal buildings and offices requiring artificial light. The Corporation is to have the option of purchasing the whole undertaking at the expiry of seven years from the date of commencing public lighting on paying the company a sum equal to the amount spent on the undertaking as shown by the Board of Trade return and certified by their auditor plus a profit of 15 per cent. If this option is not exercised at the expiry of seven years the Corporation to have the further option of purchasing at the expiry of 14 years on similar terms, but with the addition of 10 per cent. profit instead of 15 per cent. One year's previous notice of intention to purchase to be given by the Corporation. The Corporation to agree that the machinery and undertaking generally shall be exempt from rating, and that no other

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company or firm shall supply electricity during the continuance of the provisional order. Whilst the public authority of Wycombe has been considering the introduction of the electric light into the town, a private firm has been acting for itself, and an installation has been completed at Mr. Jonathan Plumridge's Desborough-road Sawmills by Mr. F. W. Dickinson, of St. Ann's Electrical Works, Leeds. The installation consists of six arc lamps of 2 000 c.p each and 12 incandescent lights for the workmen's benches, etc., of 20 c.p. each. The current is supplied by a dynamo driven by a vertical high-speed engine made especially for electric lighting by Messrs. Marshall and Sons, of Gainsborough. Mr. Hammond, who recently acted as consulting engineer to the Corporation, has delivered a lecture at the free library on electric lighting. As an example of the cost of the light Mr. Hammond referred to the installation at Leeds, where, notwithstanding the fact that gas was only 2s 2d. per 1,000ft., the electric light company made a profit of 1 per cent. on the first complete year's working. He also gave extracts from accounts of consumers at Leeds, from which it appeared that the bill of a draper with 22 lights for the year was only £9 7s ; another, with 116 lights paid £29 10s. 6d ; a butcher with 20 lights, £7. 19s. 6d. ; a jeweller, with 92 lights, £20; another jeweller, with 132 lights, £20. 19s. ; and so on. Mr. Hammond also alluded to the healthy character of the light and the fact that illness in the Post Office had decreased by 60 per cent. since it had been used, and referring to the question of competition with gas he said that either the Corporation or a company coming to High Wycombe should be able to supply electricity at a price which would fairly compete with gas at 3s 6d. or 4s.

Blackpool.—Mr. Hesketh's report on the question of charges for electricity and proposed extensions has just been issued In reference to the scale of charges Mr. Hesketh remarks : "Under the Blackpool Electric Lighting Order, 1890, we are entitled to charge 'for any amount up to 20 units, 13s. 4d. ; and for each unit over 20 units, 8d.' We are also entitled to demand security and undertakings to take a certain supply for a period of two years from commencement of supply. At present our charges are : for any quantity used for incandescent lighting or for arc lighting, where charged by meter, 6d. per Board of Trade unit. Subject to the accounts being paid within one month of being rendered, the following discounts are allowed : on quarterly accounts to £5, 5 per cent ; £5 to £10, 7½ per cent. ; £10 to £20, 10 per cent. ; £20 to £50, 15 per cent. ; £50 to £100, 20 per cent. ; over £100, 25 per cent. To this scale there are at present only two exceptions : (1) the public arc lighting is charged at a uniform rate of 4½d. per unit irrespective of demand ; and (2) the Winter Gardens, under the first scheme of charges, had supply to arc lamps at 4d per unit, less 10 per cent This rate has not since been changed. The result of this scale of charges is that those of our consumers who use most energy, however and whenever demanded, have the best terms—the reason for this being that the custom of the largest consumers was considered as most valuable to us. This is true to a certain extent, and has up to the present worked well—whether it is advisable now to change it or not is for the committee to decide. The following are those consumers who have hitherto had the advantage of the full 25 per cent discount : Empire Theatre, Prince of Wales Market, and Winter Gardens. Those who reach the 20 per cent. scale are : Clifton Hotel, Imperial Hydro Hotel, and Victoria Pier Company. Many reach 15, 10 and 7½ per cent., and all have the opportunity of having 5 per cent. It is my firm conviction that upon this scale of charges the works will pay. There is a point at which consumption is as cheap for a consumer to supply his own electrical energy as to buy it from us on this scale. Seeing that the greater the demand the lower the cost of production (everything else being equal) it follows that we can make cheaper than they can, because, in addition to their demand, we have the demand from other consumers ; and therefore I maintain that rather than allow any large consumers to put down their own plant, it would be to our advantage to offer them terms just equal to or just below those on which they could supply themselves. For this reason alone I would recommend that we do not increase the price of supply to the largest consumers beyond 4½d. per unit. As the controversy on charges seems to have ranged round the Winter Gardens Company, I may be allowed to give data as to their consumption during the past four quarters : total units, 77,914·4, cost £1,390. 0s. 8d. ; or, an average of 4·3d per unit. The fact that the Winter Gardens have a demand which is very irregular, is to a great extent counterbalanced by the fact that in the season they have an afternoon demand of some magnitude." Mr. Hesketh describes the extent and capacity of the present plant at Blackpool, and says that the Corporation have overspent their borrowing powers, which amount to £50,577, by £739. The sinking fund amounts to £2. 11s. 4d. per cent , which is equal to the "antiquation" of the whole plant in 25 years Owing to the rapid advances made in the type of plant, it is advisable to supplement this £2. 11s 4d. per cent. by a further fund. The sinking fund for repayment of loans in 25 years is £2. 11s 4d. per cent. ; for 20 years, £3. 10s. 9d. per cent. : and for 15 years, £5 3s. 8d. per cent. ; and to decrease the period of total redemption to 15 years means the increase of the sinking fund by £2. 12s. 4d. per cent. per annum. It follows that on this calculation the total depreciation amounts to £3,162, or just over 6 per cent. Against this the Corporation are compelled by the Local Government Board to put by £2. 11s. 4d. per cent , and in addition all renewals, repairs, etc., are met out of maintenance, and therefore the plant can always be considered as approximately kept up to the original standard of efficiency out of the working expenses It appears, therefore, that every reasonable contingency would be met if a further provision of 2½ or 3 per cent. on the total capital were placed to a reserve fund every year. From a return supplied, Mr. Hesketh shows that the profit for the past half-year ending September 30, 1895, is £300, which can be set off to reduce the loss of last year. The report adds that "the question as to new consumers requires consideration. Intending consumers will not send in their applications so long as they know they cannot be supplied, yet we have received applications for fully another 100 kilowatts supply, even excluding the additions to the Winter Gardens and to the public street-lighting. With these two last items we should, if extensions are gone on with, have to connect to the mains within the next 12 months fully 200 kilowatts more than at present. At least four months must elapse before we can have the first of any new plant running for supply, and therefore, if extensions are to be gone on with, some definite steps must be taken at once. We have hitherto used Lancashire boilers exclusively, and they have done their work well, with one exception, which is that on account of our load being a maximum for only about four hours of the day. If steam is to be raised in Lancashire boilers for these four hours it involves alternate strains of expansion and contraction, which eventually weaken and damage the boiler. A Lancashire boiler for safe constant working cannot be improved upon, but for rapid steam raising to take a maximum load it is not altogether adapted. Not only so, but for equal power it takes up more room than any other type of boiler, and it is my wish to put before the committee a scheme by which the extensions can be carried out under the same roof as the present plant, and so avoid not only the extra capital cost of new buildings, but the increased working cost which would naturally accrue from more extended premises with plant scattered over a wider space. I would, therefore, recommend the placing of two boilers of the marine type between the two existing batteries, which would give us a further capacity of 1,000 h p., and a slight margin for space. Not only so, but the marine type of boiler lends itself particularly to the use of induced or forced draught. This is important, seeing that for three hours of the day our chimney capacity is also deficient, and that if we use Lancashire boilers we shall be obliged to build another chimney. With marine boilers and induced draught even now a new chimney will not be necessary." In reference to engines and dynamos, Mr. Hesketh remarks that "hitherto the custom has been to consider these separately, but the most recent practice is to build the dynamo round the flywheel of the engine. By such means we can get 500 h.p., or 300 kilowatts, into a very much smaller space than we otherwise could have done. But seeing that all the space is already taken up in our engine room, the following is the best recommendation I can make : The three small arc dynamos and engines are comparatively inefficient — that is to say, they can only give an efficiency of 40 per cent., whereas the larger engines can easily give 80 per cent. I would therefore recommend that these three small engines be replaced by two large engines of 500 h p. each. Into the same space as that now occupied by 180 h.p. we should get 1,000 h p. The cost of each of these small sets of plant complete was originally £831, or say, £850. Supposing that we can now get half-price for these engines and dynamos, we entail a loss of £1,275, against which is to be placed a saving in buildings and an economy in working the station. I feel sure that the cost of buildings alone to cover the new engines will far exceed this amount, and from the plan the new arrangement of plant gives a far more compact and workable station than we have at present. The alternative to this scheme is to build an extension to the present building, and place in it the new engines and dynamos, but I do not recommend this. In the specification for the boilers, I have provided against trouble from smoke ; in the engines, the arrangement of steam-pipes prevents the escape of moisture into the street ; and in the dynamos I propose to insert clauses as to immunity from trouble through noise. I have inserted a clause in the specification that the contractor for the dynamos must guarantee that in the quiet hours of the night, with the windows of the works open, the occupants of houses in the adjoining streets shall not be able to distinguish whether the engine is running or not. Provision for a further 25 street lamps has been made, together with a rearrangement of the circuits, so that no two adjacent lamps are on the same circuit. To complete the engines and dynamos alone will take four months, and unless orders are placed before January we shall be unable to meet next season's demand. Although in this scheme I have allowed for the addition of 1,000 h.p., the specification is so drawn that only half the scheme need be undertaken immediately if the committee so decide. In my opinion, however, the full scheme is necessary under the existing state of affairs."

PROVISIONAL PATENTS, 1895.

DECEMBER 16.

24049. **Improvements in electrical contacts.** Adrien Joseph Moulart and Artien de Galard, 8, rue des Princes, Brussels.

24055. **Improvements in the construction of electric cable joint-boxes, more especially for those of concentric type.** Robert Cornelius Quin, 18, Hamilton-road, Brighton.

24079. **Improvements in collectors for electric railways and tramways.** William Edward Parry, 70, Chancery-lane, London. (John Parry, United States.)

24092. **Contact apparatus for night and sound signalling and telegraphing.** Cornelis Vreede, 323, High Holborn, London. (Complete specification.)

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24098 **Improvements in continuous-current generator-dynamos or motor-dynamos.** Albert De Puydt and Maximilien Poncin, 60, Queen Victoria-street, London. (Complete specification.)

DECEMBER 17.

24136. **An automatic check or governor for controlling the trolley (trolley-wire system of electric traction).** Henry Brecknell and Thomas Bradley Holliday, 64, Lawrence-hill, Bristol.

24151. **An automatic electric fog signal and general danger signal indicator and communicator.** William Edward Penfold, 50, Culmore-road, Peckham, London.

24165. **Process for hardening the active material on the positive plates of secondary voltaic batteries.** Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London.

24166. **Improvements in incandescent electric lamps.** The Edison and Swan United Electric Light Company, Limited, and Edward Alfred Gimingham, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24172. **Improvements in or connected with galvanic batteries.** Armand C. Iwanoski, 6, Lord-street, Liverpool.

DECEMBER 18.

24222. **Improvements in multiplex telephony.** Daniel Sinclair, 62, St. Vincent-street, Glasgow.

24264. **Resistance switch apparatus for starting electromotors.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

24296. **Improvements in or connected with rotary electric transformers.** Alexander Bewicke Blackburn and Wilfrid L. Spence, 47, Lincoln's-inn-fields, London.

24304. **Improvements in incandescent electric lamps.** Mark Bailey and John Warner, 21, Finsbury-pavement, London.

DECEMBER 19.

6565A. **Improvements connected with the electrolysis of chlorides and other salts, and the evaporation of solutions.** Harry Tee, 15, Water-street, Liverpool. (Date claimed under Patents Rule 19, March 30, 1895.)

24354. **Improvements in electrical switches.** Charles Mark Dorman, Reginald Arthur Smith, and Herbert George Baggs, Ordsal Electrical Works, Salford, Manchester. (Complete specification.)

24375. **Improvements in electric arc lamps.** Ignace Hippolyte Hegner, 6, Lord-street, Liverpool. (Complete specification.)

24393. **Improvements in reflecting incandescent lamps.** Audley Charles Miles and Bernhard Fietz de Morgenstern, 151, Strand, London.

24394. **Improvements in and relating to galvanic batteries.** Audley Charles Miles and Bernhard Fietz de Morgenstern, 151, Strand, London.

24398. **Improvements in means for controlling or directing electric currents.** Charles Pollak, 47, Lincoln's-inn-fields, London.

DECEMBER 20.

24437. **Improvements in electrical and other gas lighters and extinguishers.** The Anglo-Swedish Trading Association, Limited, and Oscar Ehrenfried Woollert, 64, Aldersgate-street, London. (Complete specification.)

24443. **Improvements in portable electric lamps for use in mines and other places.** Sydney Ferris Walker, Cardiff Electrical Works, Severn-road, Cardiff.

24444. **Improvements in holders for electric glow lamps and analogous electrical contact devices.** Emil Hungerbühler and the Electrical Company, Limited, 433, Strand, London.

24447. **Improvements in the separation from their cathodes of electrically precipitated gold and silver from cyanide solutions.** Charles Maria Pielsticker, 60, Queen Victoria-street, London.

24465. **An improved electric contact button.** Audley Charles Miles and Bernhard Fietz de Morgenstern, 151, Strand, London.

24466. **Improvements in electric indicators.** Audley Charles Miles and Bernhard Fietz de Morgenstern, 151, Strand, London.

24467. **Improvements in incandescent lamps.** Audley Charles Miles and Bernhard Fietz de Morgenstern, 151, Strand, London.

24471. **Improvements in devices for protecting electric circuits and apparatus from injury by excessive electrical potential due to lightning or other cause.** Valere Alfred Fynn and Easton, Anderson, and Goolden, Limited, 47, Lincoln's-inn-fields, London.

24472. **Improvements in dynamo-electric machines.** Valere Alfred Fynn and Easton, Anderson, and Goolden, Limited, 47, Lincoln's-inn fields, London.

24473. **Improvements in or connected with incandescence lamps and filaments therefor.** Charles Henry Stearn, 47, Lincoln's-inn fields, London. (Charles Frederick Topham, Switzerland.)

DECEMBER 21.

24503. **Improved electric insulators.** Robert Atherton, 8, Quality-court, Chancery-lane, London.

24514 **Improvements in means or devices for holding electric incandescent or glow lamps.** Robert Hacking and John Bennett, 78, Fleet-street, London. (Complete specification.)

24516 **Improvements in secondary voltaic batteries.** Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24539. **Improvements in electric regulators.** Audley Charles Miles and Bernard Fietz de Morgenstern, 151, Strand, London.

24556. **Improvements in suspension devices for electric and other lamps.** Etienne Jullien, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1890.

7219. **Electric meter.** Perry. (Second edition.)

1892.

15120. **Electric accumulators.** Headlands. (Second edition.)

1894.

25031. **Electricity meters.** Hookham.

1895.

825. **Arc lamps.** Mann and Hermand.

1676. **Electrical storage batteries.** Marchant and Woolley.

1899. **Electric railways or tramways.** Mapple.

1940 **Electric switches.** Hopkinson and Wood.

2366 **Electro-dynamometers.** Siemens Bros. and Co., Limited, and Lauckert.

2373 **Telegraph-pole socket joints.** Bullers, Limited, and Chambers.

2817. **Electrical conductors.** Edmunds.

7600. **Primary batteries.** Rowbotham and others.

20047. **Incandescent electric lamps.** Edison and Swan United Electric Light Company, Limited, and Woodley.

20214. **Galvanic batteries.** Boynton.

20392. **Arc lamps.** Wheless.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-6½
Brush Company, Ordinary	5	1¼-1½
—— Non. Cum., 6 per cent. Pref.	2	1¼-2⅛
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5½-5¾
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7½
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	12¾-13½
—— 6 per cent. Cumulative Pref.	10	15½-16
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	130-132
—— 5 per cent. Pref. Shares	10	14¾-15½
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	6	8½-9
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1⅞-2¼
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅞-1
—— 7 per cent. Cumulative Pref.	2	2-2½
Elmore's Copper Depositing	2	1-1⅛
Elmore's Wire Company	2	⅞-1
Fowler-Waring Cables	5	2-2½
W. T. Henley's Telegraph Works, Ordinary	10	13¾-14½
—— 7 per cent. Preference	10	15½-16½
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4¼-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	18-19
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge Ordinary	5	7¾-8⅛
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅜-8⅛
Liverpool Overhead Railway	10	11⅝-12
—— 5 per cent. Pref.	10	15½-15¾
—— 4 per cent. Mortgage Debentures of £100	100	114-116
London Electric Supply	5	⅞-1
Metropolitan Electric Supply	10	10½-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	5¾-6½
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15½-16½
—— 5 per cent. Non. Cum. Third Pref.	5	6¼-6½
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8½-9
Oriental, Limited, £1 shares	1	1-1⅛
—— £5 Shares	5	7¾-8½
—— £4½ shares	4½	6¼-6¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-106
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8¼-8¾
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅜-5
Westminster Electric Supply, Ordinary	5	8¼-8¾
Yorkshire House-to-House	5	6¾-7¼

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NOTES.

Electricity in Gold-Mining.—At Piggs Peak Mine, in South Africa, the 30-stamp mill recently erected will be driven by power electrically transmitted from the waterfalls about six miles distant.

Telephone Difficulties.—All the telephones in Naples were rendered useless for a time last week owing to one of the wires of the electric lighting at Chiaia coming into contact with the telephone wires.

Telephone and Telegraph.—The head of the Telegraph Department at Valencia (Spain) has decided that several telephone lines that have been erected and worked without the consent of the authorities being obtained should be summarily cut. *El Telegrafista Español* would be greatly pleased if other local heads of departments were to look up similar cases of unauthorised telephones in their various districts and treat them in the like manner.

Electrotherapeutic.—A paragraph has been going round the Continental electrical papers on a method of stimulating the nerves of the stomach devised by Drs. Einhorn and Ewald. Currents of from 15 to 25 milliamperes are used, and the patient, having previously drank a quantity of water, has passed into the stomach a perforated vulcanite capsule containing one of the electrodes, the connection being maintained by a wire insulated by an indiarubber tube. Dyspepsia is unpleasant, but one would imagine this remedy was as bad as the disease.

Utilising the Scorcher.—Various devices have been invented for enabling the cyclist to train or take his exercise indoors during bad weather. It has occurred to a French electrician that he might at the same time be doing some useful work. Accordingly, an apparatus is described in *L'Etincelle Electrique* by which the driving wheel of a safety bicycle of the usual type is raised from the floor and by means of a strap and speed gearing drives a small dynamo which is used to charge accumulators. The arrangement is designed to give a current of seven amperes at 20 volts.

The National Electrical Exposition in America. An electrical exposition under the auspices of the National Electric Light Association, and approved by the American Street Railway Association, is being planned to be held next May. The convention will be held in the New York Industrial Building, Forty-third-street and Lexington Axe, and the business will be conducted by the National Electric Exposition Company, which has been formed for the purpose. The Industrial Building was constructed expressly for exposition purposes; it has seven storeys, with roof garden, a lighting plant of 5,000 incandescent lamps, and a spare steam plant of 300 h.p. The office of the Exposition Company is at 126, Liberty-street, New York. It is contemplated to make this the greatest electrical exposition ever held.

Marine Engineering Design.—The council of the Institution of Junior Engineers, 47, Fentiman-road, London, S.W., announce that arrangements have been completed for a course of six lectures on this subject, to be given by a gentleman of long experience on the North-East Coast, and now occupying the first position in the designing department of one of the leading London marine engineering works. The lectures will be specially prepared to be of practical benefit to those attending them, the great importance of economical, as well as efficient, design being kept in view throughout; and as there will be many questions considered affecting steam-engine design generally, they will be of interest and value to engineers not exclusively engaged in marine engine work. The following are the dates of delivery: February 3 and 17; March 2, 16, and 30; and April 13, at 7.30, at the Westminster Palace Hotel. The fee for the course is 12s.

Thunderstorms.—M. Albert Nodon has communicated to *L'Electricien* the results of certain researches made in connection with the department of physics at the Sorbonne. A Mascart electrometer was connected by a thin insulated copper wire to insulated metallic discs placed at some distance from each other in the open air, and it was found that the maximum potential obtained was the same during any one storm, and was independent of the distance of the disc from the spot where the lightning discharge took place. It is concluded from this that a thundercloud acts as an efficiently good conductor to be considered as presenting an equipotential surface, and that the electrical equilibrium, so far as the cloud is concerned, is rapidly re-established after each flash of lightning. It was possible to tell when a flash was about to occur by noting the rate at which the electrometer readings progressed towards the maximum.

A Suspended Beam Electric Tramway.—The *Electrical Review* of New York has some illustrations of an interesting suspended beam electric tramway, put up by the Brown Hoisting and Conveying Machine Company, of Cleveland, at the works of the National Carbon Company at Cleveland. The system consists of an electric travelling hoist running on a suspended beam track. The hoist is suspended from four axles, with track wheels, which run upon a track made of 10in. channels, with the flanges inwards. These channels are spaced about a foot apart. The motor is a 10-h.p. Brush mining type, designed for 220 volts. The current is communicated to the machine by means of two trolley wires, one on either side of the channel-iron track. The hoist has been erected for the purpose of transferring bulky furnace tops, weighing from 3½ to 4 tons each, from one furnace to another.

Bare Conductors.—The following exemplifies the dangers attached to the practice of fixing bare electric light conductors on the same post as telephone or other circuits, particularly where the former carry high-tension currents. At Grunberg, in Silesia, the other day, a linesman named Weinhold mounted one of the high poles to attend to some repairs to the telephone wires under the impression that the electric light circuit was switched off. Standing on one of the insulated hooks of the telephone line, he was about to secure himself by passing a rope round his body and the pole when his head touched one of the bare electric light mains above, and he received the full force of the 10,000-volt current. The result was that he immediately fell from the top of the pole to the ground and broke his spine. There were considerable burns on the neck and feet clearly showing where the current had entered and left the body, and the unfortunate man died almost immediately afterwards.

A French View of the Voltage Question.—M. Mondon, of the Compagnie Electrique de la Loire, has communicated a note to the Chambre Syndicale des Industries Electriques in reference to the regulation of September 15, 1893, which authorises the use of bare conductors when the difference of potential does not exceed 120 volts for alternating and 400 volts for continuous currents. "It results from this regulation," he remarks, "that insulated wires must be used when the three-wire system is adopted with alternating currents, since there is a difference of potential of 240 volts between the two outside wires. But a pressure of 240 volts alternating is much less dangerous than one of 400 volts continuous, and it would therefore be reasonable to authorise the use of bare conductors with alternating currents provided that the pressure did not exceed 240 or 250 volts. Assuming that

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the danger is proportional not to the effective but to the maximum pressure only $150 \times 52 = 355$ volts should have been allowed in place of 400 for a continuous current."

France.—The principle of electric traction may now be regarded as fairly established in France, at any rate so far as concerns the provinces. The system has been started already at Havre, Dijon, Bordeaux, Lyons, Cimiez, Toulon, Rouen, and other towns, and a very large number, indeed, of lines are either projected or in course of construction, so that *L'Energie Electrique* remarks that on all sides endeavours are being made to substitute electric for horse traction. In almost every case the overhead system is adopted, but one line, from Nice to Cimiez, is run with accumulators. The pattern of these has, however, been more than once changed. There has also been some advance in the use of gas-engines in place of steam for generating purposes, but with the exception of Cambrai the gas companies have done little to encourage these. The use of petroleum-engines as auxiliaries to water power on occasions of short supply may be also noted, as this removes one of the difficulties in the way of the utilisation of much energy which now runs to waste.

The Light from a Crookes Tube.—There has been telegraphed from Vienna the summary of an article in the *Presse* in reference to a discovery made accidentally by Prof. Röntgen, of Würzburg, while experimenting with Crookes vacuum tubes. The discovery, which is stated to have been accepted by Prof. R. Boltzmann, of Vienna, is in effect that a photographic plate is affected by radiations from a Crookes tube, which are entirely beyond the range of the visual or what has hitherto been considered the photographic spectrum. While metallic conductors are opaque to the new radiations, wood and many organic substances are transparent to them, so that by their use it has been possible to obtain a photographic image of a metal object enclosed in a wooden case. It is suggested in Vienna that these radiations are really an extension of the ultra-violet spectrum, but there is, of course, the possibility that the effect is due to undulations of a comparatively long period. If the discovery is substantiated, further details will be awaited with interest. The repetition of the experiment has not yet been successful in Vienna, where the Crookes tubes at the disposal of the experimenters were not sufficiently large.

Pressure and Conductivity.—An article by Gustav Tammann in *Zeit. Physikal. Chem.* is summarised in the *Journal* of the Chemical Society: The influence of pressure on conductivity may be divided into three factors: (1) volume alteration; (2) alteration of viscosity and ion friction; (3) alteration of the degree of dissociation. The effect of pressure on viscosity has been determined by Cohen for sodium chloride solutions: the viscosity of solutions of small internal pressure diminishes with increase of pressure, the reverse obtaining with solutions of high internal pressure. The effect on the dissociation constant is given in a table of percentage alteration due to pressure of 500 atmospheres for solutions of varying concentration and dissociation. The total effect is then considered and typical curves are given. At infinite dilution, factors 1 and 2 alone are weighty, and these cause an increase of about 4·5 per cent. (for 500 atmos.). If the concentration increases, there are three types of curves: (I.) where the electrolyte is feebly dissociated, the curve rises to a maximum and slowly falls; (II.) where the dissociation is great and factor 3 of small account, the curve is at first almost parallel to the axis of concentration, then slowly sinks owing to the effect of the viscosity, and finally cuts the axis; (III.) for intermediate dissociation, the rise is not as rapid as in (I.), and a well marked maximum occurs. The curve is also given in the case of sulphuric acid, which is shortly considered; a maximum occurs here at concentration 0·5 per cent. and a minimum at 85 per cent.

The Electrical Trap Again.—The *Indian and Eastern Engineer* is responsible for the following: "All dwellers in India whose tempers have been at times ruffled by the persistent and extremely inharmonious efforts of crows to make their presence known will be glad to hear, according to a contemporary, that an electrician has directed his attention to their extermination. In fact, the *corvus impudicus* is to be electrocutioned; but the act will be suicidal, and this is how he proposes to make him carry out that act: Between two metallic horizontal bars, which are the positive poles of a powerful battery, is hung a wire basket, which is the negative pole of the battery. In this wire basket is placed moistened food, which can only be got at by a bird perching on either of the aforesaid horizontal bars. The birds cannot see each other from these bars. Below these perches is fixed a large box, with slanting pivoted tops, which is got at from the room without any fear of being seen by the birds outside. As soon as a crow perches on one of these bars and begins to draw the moistened bait out from between the meshes of the cage, he establishes the circuit, is killed, and drops on to the slanting lid of the box, which revolves and deposits him for future cremation in the box, and adjusting itself hides the criminal from further view."

Niagara Falls.—The New York *Engineering Magazine* for December contains an article by the late Franklin Leonard Pope on the "Distribution of the Electric Power Obtained from Niagara Falls." In the article, which was left incomplete by the author's sudden death and is finished by his brother, Mr. R. W. Pope, it is remarked that the results which have been already attained culminating on the transmission of electric energy to the amount of some thousands of horse-power to the works of the Pittsburgh Reduction Company, make it certain that the vicinity of the Falls will in time become one of the greatest manufacturing districts of the United States. But the question of the transmission of power to a distance so as to compete with steam power produced on the spot still awaits its solution. In spite of the favourable opinions expressed by many electrical engineers, it is noted as significant that, so far as can be learned, no work has actually been commenced upon the transmission line to Buffalo. It is urged that it is not always safe to base important plans upon possible economies. In the case of steam plants, the economy to be derived from grouping plants so as to work from a central power station operated at high efficiency has to give way to the local convenience of separate plants. It might result that the flexibility of electrical distribution would lead to the substitution of the motor for the steam-engine where the question of heating was of little importance. It is concluded that all manufacturing enterprises in the United States, unless of a strictly local character, will be henceforth located only after a thoughtful consideration of the great advantages of Niagara.

Steam Ploughs.—A consular report of Mr. O. Döderlein, United States Consul at Leipsig, deals with the application of electric motors to steam ploughing in Germany. In the usual system of steam ploughing, in which the plough is pulled by a wire rope coiling on a drum, the friction of the rope is very great, so that the horse-power required at the engine is quite disproportionate to that which is available at the plough. Moreover, the rope wears rapidly and is costly to replace. These considerations proved fatal to the "all round" rope system with one engine, leaving at present only the double-engine

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system, with its double expense for capital and attendance, to maintain a precarious existence down to the present time. An obvious improvement would be to make the plough drag itself along a fixed rope, but short of taking a more or less heavy steam-engine across the field there was until the advent of the electromotor no convenient method of supplying energy to the plough. The suitability of a dynamo and motor for this purpose is obvious at first sight, and it is probable that had not the condition of agriculture in this country been such as to offer no encouragement to projects involving the outlay of considerable capital, a system on these lines would have been worked out here. It has, however, now been done in Germany with some success. The plough, carrying an electromotor, pays out and picks up a separate conductor cable as it crosses the field, and the cost of working is stated to be about one-half that of oxen. No details are given in comparison with horses. As, however, in the experiments given a 10-h.p. engine was required to work a two-share plough, there is evidently still room for improvement, since two single-furrow ploughs would require only four actual horses to work them, or, since the soil is stated to be heavy clay, six horses at the outside.

Piano-Playing by Electricity.—In the current number of the *Scientific American* is an article on an electric apparatus which can be attached to any piano, enabling it to be played without the intermediation of any performer. The apparatus is fixed immediately under the keyboard of the piano, and is so constructed that it can be fed with perforated music-sheets. Electric contacts are provided for each note, which contacts operate through the perforations in the music-sheet, so that each perforation closes an electric circuit. From the electric contact, wires run to a series of electromagnets placed below and corresponding to each key of the instrument. When the current passes, a magnet attracts its armature, and this occurs when one of the perforations closes the circuit. A long brass drum runs across the bottom of the apparatus and is kept in constant rotation by an electric motor. Extending from the end of the armature of each magnet is a metal friction shoe, the lower end of which forms the segment of a circle, and is arranged to be brought in contact with the brass drum. A piece of raw hide is cemented to the outside of the segment, and when the armature is depressed it brings the raw hide-covered face of the segment into contact with the rotating drum and the friction at once throws the arc forward. From the upper end of the metal shoe a short arm projects at right angles, and from this a vertical striker arm rises and presses against the inner end of the key, which is then set in motion just as if the outer ivory-covered end were depressed by the finger of a performer, and the note sounds. It is stated that this apparatus does not affect the capacity of the piano for being played by hand. It is also stated that the motor consumes from five to ten amperes at a pressure of four volts, ten amperes being required when several notes at once are sounded, as in a chord.

Utilisation of Mountain Streams.—Mr. Bunten, the proprietor of Rannoch (Perth) has recently put down an electrically-driven threshing machine at his home farm, and it was exhibited about a week ago to a large number of Perthshire agriculturists. The contents of three burns which come down the side of Schiehallion are discharged into a dam fully three-quarters of a mile from the mansion house. From the dam the water is conveyed fully 500 yards in 10in. iron pipes to the dynamo-house. In the dynamo-room there are two turbines and two dynamos. The turbines are 12½ h.p. each, and arrangements are made so that one turbine and one machine can run, or the two together if required. The current is led by two conductors from the dynamos to the mansion house, a distance of between 400 and 500 yards, and there are branches from the house to the stables and laundry, about 200 yards beyond. The premises are fitted with fully 300 lamps, of which from 150 to 160 are generally in use. As the capacity of the cable is sufficient to carry double the number of lights that were originally fitted up, Mr. Bunten (who is managing partner of the Anderston Foundry Company, Glasgow), after deciding on making an experiment as to the application of electricity as a motive power for machinery, resolved to extend the cable from the mansion house to the steading, a distance of 940 yards. The difficulty in the way of using water power for this purpose is that, according to modern agricultural practice, threshing is not an operation that goes on continuously through the winter, but is done in large parcels at a time, and consequently more power would be required than is likely in most cases to be available. There are, however, a quantity of minor operations about a farmstead which are fairly continuous during the winter season, when the streams are full, and which are quite suitable for such an application of water power as is described above.

"Are We Educating Too Many Electricians?"—Mr. Henry Floy, writing under this heading in the New York *Engineering Magazine* for January, says that to meet the growing evils of what he terms "electro-mania," there is urgently needed an educating of popular thought as to the possibilities of electricity and the business opportunities offered in electrical engineering. It had been stated that the time was rapidly approaching when every central-station lighting and power plant and every form of electrical business would have their consulting and installing engineer; but he thinks such a statement misleads the public, because the electrical manufacturing business is daily tending to the production of more simple apparatus which may be operated by those who are ignorant of electrical laws, and, as a consequence, there is less and less call for the highly-educated theoretical man in the more usual practical applications of electricity. Feeling sure of the over-production of electrical engineers, and in order to secure some facts as a verification of his convictions, he sent 260 personal letters to the present year's graduates in electrical, mechanical, and civil engineering. His idea was to procure statements which would show comparatively the number of positions secured by recent graduates in these three courses, to ascertain whether influence was necessary to secure positions and to determine the salaries paid in these positions. He sent 108 electrical letters and had received 48·1 per cent. replies. Of these, 78·8 had secured employment, and 65·3 had secured employment in the line of work for which they studied; and of the total, 36·4 had secured employment through the influence of relatives and friends. The average rate of pay per hour on the basis of 5½ working days per week was 21·8 cents. The conclusions he drew from these statistics were that, while a greater percentage of the graduates in electrical engineering secure employment as compared with the other graduates, yet the fewest, relatively, secure employment in the line of work for which they had studied—that is, in order to get employment, they had to take positions in which their electrical knowledge did not count. Assuming 5½ working days per week for each of the three professions, the electrical graduate received over 20 per cent. less per hour than the mechanical graduate (who received 27·4 cents), and 23 per cent. less than the civil graduate (who received 28·5 cents).

Thermo-Electricity.—Profs. J. Dewar and J. A. Fleming have determined the thermo-electromotive force

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at temperatures as low as the boiling point of liquid air; the couples were in all cases prepared by the junction of the metal wire, "M," with a lead wire, and the observations were afterwards reduced to those of a couple of "M" with pure lead. Measurements were taken at about 30 temperatures between 100deg. and −200deg. (the temperature being determined by a platinum resistance thermometer, and recorded in "platinum degrees"), and very careful measurements were taken at fixed temperatures—that is, the boiling point of oxygen, melting point of solid carbonic anhydride, etc. The metals examined were platinum, gold, palladium, silver, copper, zinc, cadmium, magnesium, tin, iron, nickel, steel, manganese steel, maganin, German silver, platinoid, bismuth (A, B, and C), antimony, and aluminum, and also carbon. The lines (E.M.F. against T) are in all cases curved, with frequently a maximum, but none are exact parabolas. Some have changes of curvature, so that the lines of thermo-electric power would be broken, whilst it is noticeable that antimony has two neutral points, and all specimens of bismuth exhibit a sudden break at −80deg. *pt.* The same authors have investigated the resistance in the case of three samples of bismuth: (1) commercial pure bismuth (A); (2) and (3) pure samples specially prepared (B and C), the temperature varying from 95deg. to −235deg. (platinum degrees). In each case the specific resistance at first diminishes, a minimum being reached at −50deg. *pt.* (B), −83deg. *pt.* (C), and 0deg. (A); after this the resistance increased, the temperature coefficient being negative. In the case of the commercial bismuth (A), a maximum was reached at about −200deg. *pt.*, after which the temperature coefficient was again positive; but in the two pure samples no such maximum occurred, neither was there any indication that a maximum would be reached. It is noticeable that the change in the temperature coefficient of the pure bismuth (especially C) occurs at about the same temperature as that of the discontinuity in the thermo-electric power. It is also found that the effect of a magnetic field on the resistance of the metal is very much increased by reduction of temperature, an increase of 5 per cent. due to a magnetic field reaching 25 per cent. at the temperature of liquid air.

The Electric Railway Chronograph.—The running of a street car from the time it leaves the terminal shed to its return is frequently supposed to be dependent entirely on the motorman and the conductor, but the movement of the car all the time is known to the superintendent in the central office. He simply consults a chronograph and immediately learns whether the cars are running regularly or irregularly; whether there is a stoppage at any point; how long it lasts; how many cars are blocked; and when the trouble is removed and the road begins operations again. This chronograph constitutes a sort of living map of the road, by means of which the superintendent can take a bird's-eye view of the whole operation of the line. If there is a bad break, he can send instructions to fill in with extra cars. If there is irregularity in the running time without good cause, he can check it, and, if necessary, trace the exact car which is responsible for the deviation from schedule time. The manner in which all this information is obtained is extremely simple. The chronograph consists primarily of a sheet of paper moving at a uniform rate under a series of pens or points operated by magnets. Each magnet point represents a point on the road, and each time a car passes this point on the road it makes contact, and the magnet point on the chronograph makes a mark on the paper. On the frame of the instrument is mounted a back roller to hold a supply of paper, the front roller on which to roll up the record, the top plate holding the magnet points, and the roller, which gives the time movement to the sheet. This top roller is a series of grooved wheels, one for each magnet point. The importance of this part of the device is obvious, since the movement of the sheet must be absolute and exact or there will be inaccuracy in the time record. This roller is actuated at the rate of one revolution an hour by a powerful clock movement. This gives the paper 4in. of movement in the hour, or 1in. for every 15 minutes. A line running on the one-minute schedule will, therefore, show 15 cars or prick marks to the inch, a five-minute schedule three to the inch, and so on. A break of 2in. would denote a stoppage of 30 minutes at that point. When the superintendent sees a regular, unbroken showing of points on the record he knows that the cars are all doing their full work. The record-sheets are dated and filed for reference, and in offices where the chronograph has been used since its introduction two years ago the company can instantly tell how the cars worked on any day in that time.

American Fire Office Rules.—The new rules agreed on by the Underwriters' National Electric Association have been published. The changes made in the rules, while considerable in number, are not radical, except in a few cases, and the following are some of the more important of them, and are given in the order of the sections amended in the present rules: The grounding of the frames of generators may be allowed when necessary by written permission. This change was made on account of the introduction of direct-connected and extremely large and heavy machines. Switches for motors must hereafter plainly indicate whether the current is on or off. Rules were adopted requiring wires to be protected from mechanical injury in buildings—where necessary, high-potential wires by substantial boxing, giving a reasonable air space, and low-tension wires either by boxing or by an approved iron-armoured conduit tubing. The mesh of wire netting for arc light globes should not exceed 1½in. Switches on hanger boards must cut out both poles of the lamp The use of wire smaller than No. 14 B. & S. will not hereafter be allowed except for pendant and fixture work. The rules for special wiring in breweries, etc., will require that joints and splices be avoided as far as possible, and that switches in damp places be mounted on porcelain knobs so as to give an air space behind them. It will hereafter be allowable to draw strings into conduits for the purpose of pulling in conductors, which should not be placed in the conduit until the mechanical work on the building has been completed as far as possible. Hereafter cut-outs will not be allowed in the canopies or shells of fixtures. Circuits must be arranged so that no group of lamps (whether on the same fixture or not) requiring a current of more than six amperes will be allowed to be ultimately dependent upon one cut-out, except that special permission may be given in writing for departure from this rule in case of large chandeliers. Hereafter, except for pendants and fixture work, a solid rubber insulation, protected by durable braid, will be required for flexible conductors. Supports for motor ceiling fans must have an insulator interposed between them and the motor. Service switches must disconnect all of the wires entering the building—that is, on the three-wire system, all three wires must be opened by the switch. The use of brass-sheathed interior conduit and vulca tubing will not hereafter be approved for bushings. The use of incandescent lamps in series circuits for decorative purposes will be allowed by special written permission, when installed in a proper manner. Rules for electric heating apparatus were adopted, which will require, in addition to the general wiring being done in accordance

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with rules, that the switches shall plainly indicate whether the current is on or off; that the attachment of the feed-wires be in plain sight; that stationary heaters be treated as stoves, and that the flexible conductor necessary for use with flat-irons and other devices of a similar nature shall have an insulation that will not be injured by heat, such as asbestos, which insulation must be protected from mechanical injury by a substantial outer braiding. The matter of obtaining more effective and more efficiently constructed devices for automatic safety cut-outs has been referred to the committee on testing with a request that they obtain all the information possible in relation to the proper construction of fuse blocks, length of fuses, and efficiency of fuse metal, and with relation to currents of various quantity and potential. A committee has been appointed to consider and report on the question of how best to guard against the hazard due to the possibility of the breaking down of the insulation between the primary and secondary transformer coils. This subject was considered of importance, in view of the tendency toward extremely high voltages in long-distance transmission. The subject of protectors which will obviate the hazard due to the liability of wires, such as telegraph, telephone, and similar wires becoming crossed with electric light or power wires, has also been referred to a committee.

Storage Battery Applications.—The *Electrical Review* of New York summarises a communication on "Past and Present Obstacles in the Storage Battery Development," before the American Institute of Electrical Engineers, as follows: Cessation of litigation and the development of the Planté type of cells make the storage battery outlook in this country much brighter; the cost of a guaranteed storage battery seems in many cases to be nearly equal to that of the direct generators to encourage their general adoption. A reduction in the cost would therefore open a large field, much larger than in proportion to the reduction; the renting of accumulators seems a commendable method of introducing them. Most of the diseases which storage batteries are subject to could be avoided or made much less disastrous by having large surfaces, small depths of active material, and free circulation. The first cost would be reduced, and the vexing question of the uncertain amortisation settled by a light, short-lived, cheap positive plate, and a cheap process of reconverting old into new positive plates. Storage batteries for slow discharges have been a success abroad; a very large additional field would be opened by a light, cheap, rapid-rate cell. The objection to a plate with a thin layer of active material is that it may not retain its charge as well as one with a thick layer of pellets, but in most cases in which rapid rates are desired or cannot be avoided, the small loss in standing is probably more than balanced by the fact that the plates are not injured by rapid rates. As a rule, long periods between charges go hand-in-hand with slow discharges, and less objection to great weight, while short periods between charges, high rates of discharges, and lightness usually go together. In conclusion, the writer of the communication took the opportunity of making the following recommendations in the interests of engineers who may have to calculate accumulator plants. That rates of charge and discharge be designated in hours and fractions, the current (or for power purposes, the watts) during that time being considered to be kept constant. There can then be no mistake as to what is meant, as this represents the time in hours during which a cell will continue to give a practically constant current before the voltage falls below its limit. That efficiencies and capacities be always accompanied by the corresponding rate in hours. That in giving an efficiency it should always be stated whether it is for ampere-hours or for watt-hours. That for portable batteries intended for power purposes the capacity be given in watt-hours instead of ampere-hours, and that the weight given be that of the complete cell ready for use, as distinguished from the weight of the plates alone. Mr. Arthur E. Childs contributed a communication on "The Storage Battery for Central Stations." He said the fact that storage batteries had reached a point of high efficiency and low cost of maintenance had stirred up engineers in their country to consider the application of storage batteries to their own plant, and thus the accumulator had assumed great importance at the present time, especially as power and light stations were so far developed that further increase in generating capacity meant large additional expenditure, and in many cases the rebuilding of the entire plant. In England and on the Continent storage batteries had been used in central stations for more than five years, and their utility and value were acknowledged throughout Europe. The great variations and fluctuations of the load on power circuits were among the greatest difficulties which engineers had to contend against, and the introduction of a storage battery into a central station acted in a certain sense as a buffer between the external load and the dynamos, taking the shock of the variations without throwing the same on the engines. As applied to power stations, and especially where water power was used, storage batteries were almost indispensable. With regard to illuminating plants their value was equally as great, as the charging of the battery could be done while the plant was operating at light loads. At the period of heavy load the battery was able to take care of the peak of the load, and also to operate the lights when few lights were being supplied from the station. The storage battery could also be used as a valuable adjunct to both power and lighting stations at points where it was difficult to maintain the voltage at periods of heavy load. A survey of the progress which storage batteries had made in European countries indicated no very great change in the principle of construction, but the results seemed to be rather due to a thorough analysis and appreciation of the requirements of each case. The great difficulty in America had been that engineers had not recognised a proper limit to the usefulness of a battery, but had in many cases far exceeded their specified limitation, and so injured the batteries and cast discredit on them. The batteries in use in Europe had shown grea endurance and solidity, from the fact that engineers had endeavoured to obtain long life and high efficiency even at the expense of increased first cost. Great progress had recently been made in the manufacture of the batteries, and manufacturers could now produce cells having almost any given capacity. The factors which tended to reduce the efficiency of a storage battery were due to a loss in voltage and in the quantity of current; but these losses were not so serious as in the past. Mr. C. L. Edgar, in a communication on "Practical Experience with Storage Batteries in Central Stations," classed their uses under four heads: (1) to carry the peak of the load at maximum hours, (2) to carry the entire load at minimum hours, (3) to act as equaliser or reservoir, and (4) for the equipment of annex stations. Mr. Nelson W. Perry, E.M., considered that they had a more economical method to hand than the use of storage batteries. He referred to the gas-engine. In the discussion which followed, the use of the storage battery was very favourably commented on, but the idea of the gas-engine for driving the generators did not meet with much approval. A simultaneous discussion on "Storage Battery Applications" took place at Chicago.

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CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXI.

(Specially Contributed.)

Registering Ammeters.—These are instruments intended to keep a continuous record of the current in the circuit. One of the best known is that of Richard. Here we have an electromagnet, A B (Fig. 1), with an iron fan-shaped

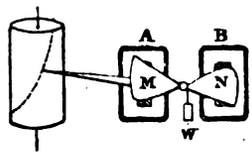

FIG. 1.

armature, M N, movable on its axle. When a current passes, the armature is attracted and turns about its axle. The motion is counterbalanced by a small weight. The armature carries a pointer, as shown, which is used to trace a mark upon paper carried by a cylinder moved by a clock-work arrangement. The indicator card made by the pointer can be read by reference to a graduated scale. Fig. 1A shows the complete instrument.

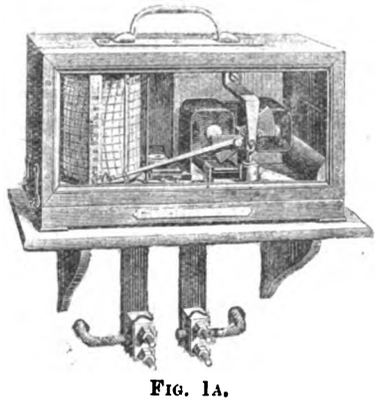

FIG. 1A.

Ammeter-Balance.—In this instrument the current through the coil of the electromagnet also attracts the armature, and the force of attraction is balanced by a weight which we can slide along a graduated scale. The position of the weight on the scale shows the current in amperes.

Electro-Dynamometers.—The instruments previously described are only useful for measuring continuous currents—that is, currents going in one direction; but we have also to deal with alternate currents—that is, currents going first in one direction, then in another. The instrument I am about to describe will do for either kind of measurement. We have seen that every conductor carrying a current is surrounded by its magnetic field, and the field of a current in one conductor has its effect upon the field of another conductor just as it has upon the field of a magnet. If, then, we have a conductor, A B, and another, F F, and pass currents through these conductors, the interaction between the fields will be to tend to place the conductors so that the lines of force of the two fields are parallel. This tendency may be represented numerically by the product of the two currents—$C \times C_1$. Thus, if the conductors are so arranged that same current goes through both conductors, the tendency will be equal to the square of the current.

If a current of x amperes goes through one conductor, A B,
and a current of y amperes goes through the other conductor, F F,
the strength of the force tending to bring A B and F F parallel is $x \times y$, or $x\,y$.

If the current in A B $= x$,
and the current in C D $= x$,

then the force $= x \times x = x^2$.

This means that if the fields of two conductors interfere, the force tending to bring them parallel is equivalent to the product of the currents in each conductor. When, therefore, the current in each conductor is the same, the force is equivalent to the square of the current.

If, by means of the torsion of a spring, the movable coil is kept at rest, the angle through which the spring has to be moved will be the measure of the square of the current. The Siemens electro-dynamometer is the best known, and will now be described. In it we have two coils, one coil fixed containing a number of turns, and usually so constructed and connected with binding screws that more or less turns can be used according as the measurement in hand requires. Examine the diagram, Fig. 2. The inner coil, F F F F, represents the fixed coil of many turns, while the outer coil, A B, represents the movable coil, usually of a single turn. The coils are connected in series through the mercury-cup, H H_1 When a current is sent through the coils, as shown by the arrows, A B tends to move so as to be parallel to the fixed coils, and is balanced by the spring. Now examine the two illustrations of this instrument (Figs. 2 and 3). F F shows the fixed coil, A B the movable coil which carries a pointer, P, with a turn at the end to point to the division of the scale. The binding screws, 1, 2, 3, admit of more or less of the fixed coils being used in the reading. Suppose, now, the source of current properly connected to the binding screws, then the current traverses both fixed and movable coil, and the latter at once moves. The index of the movable coil is brought back to zero by turning the screw, S, so as to oppose its torsion to the force tending to move the coil,

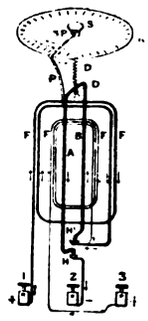

FIG. 2.

and the number of degrees through which the screw pointer, S P, is moved, in order to bring back the movable coil index to zero, must be noted. As has been said, the angle through which the torsion screw is moved measures the square of the current. The movable coil, having only one turn, is not much influenced by the earth's field, but solely by that of the fixed coil; hence there is no necessity to have the coil in a particular direction. To find the current in amperes, we have to find the square root of the angle and multiply by a constant.

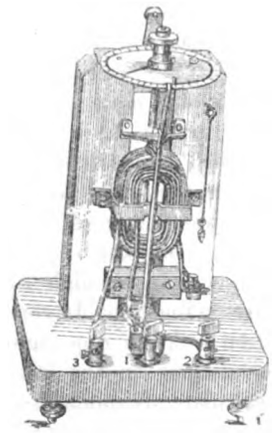

FIG. 3.

The constant used differs for each instrument, and is supplied by the makers. Usually the fixed coil really consists of two coils—one of large wire for heavy currents, the second of smaller wire for smaller currents, as is shown diagrammatically in Fig. 2.

Ammeters and Voltmeters.—The instruments hitherto described are for the measurement of current,

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but we have also to measure pressure, and a little examination will show that the instruments to measure volts need not differ in principle, though they must in construction, from those to measure amperes. Keeping in mind that the test must not alter the thing tested, and that the introduction of any testing instrument into any circuit will alter the conditions somewhat, it can easily be seen that an ammeter must fulfil certain conditions altogether different from those necessary in a voltmeter. To use an ammeter, we put it in series with the rest of the circuit, so that the total resistance of the circuit is increased by the resistance of the instrument. If, then, the resistance of the instrument is large compared with the resistance of the circuit and the pressure constant, the circuit currents before and after the insertion of the instrument may differ considerably. Just examine a case or two.

Take a circuit having a resistance of two ohms and a pressure of 10 volts.

From Ohm's law $C = \frac{E}{R}$,

we get $C = \frac{10}{2} = 5$;

i.e., we get five amperes of current.

Now, suppose we try to measure this current with an ammeter having a resistance of two ohms. The insertion of this brings the circuit resistance to four ohms.

Then $C = \frac{E}{R}$;

$C = \frac{10}{4} = 2{\cdot}5.$

We have doubled the resistance and halved the current.

Suppose our circuit consists of 40 arc lamps in series, each having a resistance of five ohms, added to which the connecting wires, etc., gave further 10 ohms resistance to the circuit, or a total circuit resistance of 210 ohms. Let the pressure be 2,100 volts.

From $C = \frac{E}{R}$,

$C = \frac{2,100}{210} = 10$;

that is, we get 10 amperes as the current. Adding our ammeter of two ohms brings the circuit resistance to 212 ohms and the current to

$$C = \frac{2,100}{212} = 9{\cdot}9,$$

a very different state of things to the other case.

Let us see what information we can gain by an examination of the formula $C = \frac{E}{R}$,

where, as usual, C = current,
E = E.M.F., or pressure,
R = resistance.

If we add another resistance, r, then the denominator becomes $R + r$,

and $$C = \frac{E}{R + r}.$$

Those who have little algebraical knowledge may look upon formulæ like $C = \frac{E}{R}$ or $C = \frac{E}{R + r}$ as division sums.

Just like

$$24) 144 (6$$
$$144$$
$$\cdots$$

where we have a divisor 24, a dividend 144, and a quotient 6.

In the formula, C is the quotient, R or $R + r$ the divisor, and E the dividend. From our knowledge of simple division, we know that increasing the divisor decreases the quotient when the dividend is constant.

When we want to measure current we want to measure the real current in the working circuit; hence the ammeter or other instrument used must have a small resistance compared with the rest of the circuit—that is, the divisor must be increased by as small a quantity as possible. When we come to measure pressure something similar holds good, but here the current should be as small as possible and the resistance as large as possible for that particular pressure. We have seen that mechanical pressure applied to a body gives it motion—of course, understanding that the body is not too large for the pressure. We can get the value of the pressure from a knowledge of the mass of the body and the velocity it acquires under the action of the pressing force, but that is not so easy a way to find the value of the pressure as is the increasing and increasing the mass causing motion till you come to the point where the addition of the slightest mass prevents motion. Let me illustrate this by a diagram.

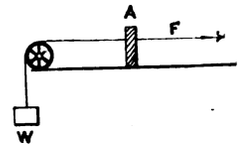

Fig. 4.

In Fig. 4 let A represent a body acted upon by a force, F. On the other side of A, I harness a weight, W, and change that weight for a larger and a larger till the force, F, is just counterbalanced, and A does not move. I can at once say that the force, F, is equal to a gravitational force of so many pounds. This balancing method is most useful in many directions. The grocer balances unknown weights with known weights, and the unknown remains unknown no longer. Similarly, we might balance electrical pressures by opposing known pressures to unknown pressures through a resistance. So long as pressures differed there would be a current in one direction, but when the pressures were equal there would be no current. This method is sometimes adopted, but not often, as it is inconvenient. Hence the more convenient method—

$$C = \frac{E}{R}, \text{ or } C \times R = E$$

is used.

But, again, we must remember that the E.M.F. does not remain constant if we take too large a current. Consider once more the water analogy. Let us have a reservoir, H, with water at the level, L (Fig. 5). Then A L is the head of

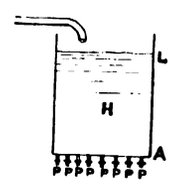

Fig. 5.

water. Suppose water can be supplied to the reservoir by the pipe, P, at the top, and taken from the reservoir by the pipes, P P P P, at the bottom. The available head of water is A L. If I open all the pipes at the bottom the rush of water out is too great for this head to be kept up, and this great rush out of water is somewhat like too large currents of electricity—in both cases it is difficult to keep pressure constant. Thus, what we do is to take a small current.

Now, in the formula, $C \times R = E$.

If C is made smaller and smaller R must be made larger and larger—that is, a small current requires a larger resistance in order to correctly measure E.M.F.

An ammeter, then, of large resistance will enable us to measure E.M.F., and many voltmeters are constructed upon the same principle as ammeters, but wound with wire of much greater resistance.

The equation $C = \frac{E}{R}$ may be read in another way—viz., that C varies directly as E and inversely as R. So that if we increase or decrease E in any way, C will increase or decrease similarly if R remains constant.

Now, the resistance of a voltmeter, or, for the matter of that, an ammeter, remains constant, leaving for the moment the change of resistance due to rise of tempera-

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ture. Take an ammeter of high resistance and join by conductors to its terminals the two points in the circuit the difference of potential between which we want to know,

then $$C = \frac{E}{R}.$$

Take the same instrument and join any other two points similarly,

then $$C_1 = \frac{E_1}{R}.$$

Thus the indications of current, C and C_1, will be proportional to the differences of potential, or pressure, and will give this difference in volts if the scale divisions be marked for this purpose.

If in the second instance the current C_1 is 2, 3, 4, or n times or $\frac{1}{2}$, $\frac{1}{3}$, or $\frac{1}{n}$th times the current C in the first instance, then E_1 will be also 2, 3, 4, or n times, or $\frac{1}{2}$, $\frac{1}{3}$, or $\frac{1}{n}$th times E in the first instance.

All, then, we have to know to make a scale is *the* E that will give a current C.

When a current of 2 C is observed, then the pressure is 2 E, and so on.

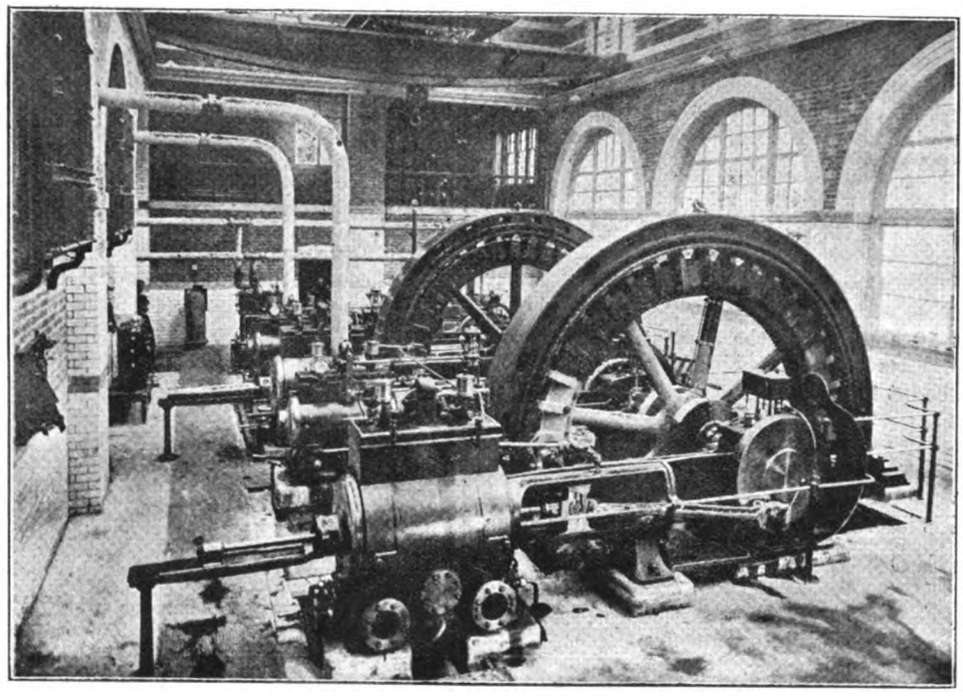
AYR ELECTRICITY WORKS.

The opening ceremony in connection with the installation of the electric light in Ayr was performed on Wednesday afternoon by Lord Kelvin, F.R.S. Provost Willock presided, and there was a large attendance, including a deputation from the Town Council of Glasgow, the Provosts of Kilmarnock, Irvine, Girvan, and Govan.

Provost WILLOCK, in introducing Lord Kelvin, gave a short *résumé* of the history of the work, and then called upon Lord Kelvin, who, he said, had come there, together with Lady Kelvin, at considerable inconvenience to himself.

Lord KELVIN expressed the great pleasure it afforded him to be present to witness the opening of such an exceedingly interesting application of science as the application of electric lighting in the town and district of Ayr. Long before such an application of electricity became a reality, it was a dream of science that electricity would at some time or other be applied for lighting and other purposes, and that day they would see its realisation in Ayr. They had to carry their minds back a good way to find the first use of electricity, but at that early date it could not be used for lighting houses. The only kind then in use was that used for lighthouses—*i.e.*, the very old discovery of Sir Humphry Davy—the electric arc light. They had to go back for a period of 60 or 70 years for their knowledge of the electric arc light. Going back 30 years, however, would suffice to take them to the time of the first useful or practical application of the electric arc light, of which he might say that even then the only practised application of electric light was still for lighthouses and very little indeed for other purposes until many years after. Fifteen years ago there came a great development of discovery in connection with the light, and that was the practicability of applying the light to other purposes for which it had not been previously designed. It was then realised that the application of the light which they were going to see that day was practicable. That discovery was chiefly due to Swan and Edison, and culminated in the Swan-Edison lamp. He congratulated the town of Ayr that it should at so comparatively early a day have come forward and that its Municipality should use electricity in that practical way. The provost had told them how they came to take the matter into their own hands, and in that he thought they had acted wisely. He was quite sure the people of Ayr at present thought their Council had done right, and he hoped and believed that after two, three, and even twenty years they would know from actual experience that the confidence they had placed in their Council had been well founded. The work of producing the engines, dynamos, and arrangements for transmitting the light from that building over the town had gone on very vigorously and successfully until it had culminated in that successful opening. That was not the time to speak of plans and machinery. Different places had different plans and different machinery, and in different countries there were large varieties of mechanism, steam-engines, and electric engines which had been chosen to do the work of electric lighting. Ayr had the benefit of 15 years' experience from the beginning of this light, and yet it was very early among the towns of Scotland to take up the matter, but under the able guidance of Mr. Hammond the work had been carried out in a manner he believed would be a credit to all concerned. It was a treat to him to see these grand engines, two of which were ready to give 100 kilowatts of power, and it gave him great pleasure to declare the electric light installation of Ayr open.

Bailie URE (convener of the Lighting Committee), in the name of the Corporation, presented Mrs. Willock with a gold bracelet as a souvenir of the occasion. Provost Wil-



View of the Engine-room at Ayr, showing the Flywheel Alternators.

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lock thanked Bailie Ure and the Council, on behalf of Mrs. Willock, for the memento, and said he was sure Mrs. Willock would look upon it with great pleasure in days to come. Mr. Robert Hammond (consulting engineer) then moved a vote of thanks to Lord Kelvin.

Lord KELVIN briefly returned thanks, and Mrs. Willock then started the machinery amid cheers. The Council afterwards entertained a company of guests to dinner in the town hall in the evening.

ARTIFICIAL ICE FLOOR FOR SKATING.

The production of a really good ice floor has for years been the aim of many engineers, but experiments on a large scale have been few owing to their costly nature and the large amount of plant required. A new system has recently been laid down at the Hengler Circus in Argyll-street, Oxford-street, the building now being called "The National Skating Palace." There are many novel features in the construction which are worthy of notice as likely to give a more uniform hardness to the sheet of ice produced, and also to result in a ready method of keeping all parts of the ice floor at a uniform temperature. This new system, which is under patents owned by Messrs. Tyler and Ellis and Messrs. J. and E. Hall, has the following essential details. The floor itself consists of a uniform sheet of ice 4in. thick, which rests on rectangular steel tanks about 2in. in depth. Through the flat closed tanks a brine solution is passed, which by its low temperature keeps the ice at the freezing point. The temperature of the brine passing out of each of these tanks is measured on thermometers near the regulation stop-valves, and if the delivery water from one is found to be warmer than the rest a quicker circulation of salt water is given. The actual temperature of the brine is about 26deg. F., the difference of temperature between inlet and outlet being only 3deg. or 4deg. F.

Under the cooling-tanks there is an insulating air-space of about 12in., then a matchboarding floor covered with lead, which rests on a layer of charcoal about 6in. thick placed on the concrete foundations. These flat tanks under the ice give a more uniform temperature, and therefore more uniform hardness, than some older systems where pipes are actually embedded in a thicker layer of ice. Any leakage of the cooling solution from such pipes is apt to discolour the ice and make it rotten. Also, owing to the great thickness of ice required to cover the pipes and to make up a level surface, the ice becomes very solid and heavy, and hence more liable to crack.

The water-tank of the Tyler and Ellis system also gives a certain elasticity to the ice which is more like that experienced when skating on a frozen pond. The refrigerating machinery at the National Skating Palace is worthy of special notice. Below the building is the boiler-room, with its battery of three 40-horse locomotive boilers, by Messrs. Davey, Paxman, and Co., of Colchester. Either two of these boilers are capable of supplying all the steam necessary for the various engines. This boiler-room is shut off from the engine-room proper by a brick wall, so that no dust may be carried over the machinery.

The machinery in the engine-room consists of two main 50-h.p. refrigerating engines and compressors, standing along one side of the gangway, while the two sets of electric light engines and dynamos are on the other. These refrigerating engines are of Messrs. J. and E. Hall's carbonic-anhydride system, and are tandem compound horizontal condensing engines. Each engine is capable of maintaining the ice surface in perfect order, and together they can freeze an entirely new floor 4in. thick in 24 hours. These carbonic-anhydride machines are superior to the older forms of refrigerating machines, in which ammonia and other chemicals were employed, owing to the far greater refrigerating effect of carbonic anhydride and to its being an odourless innocuous gas, which latter is of the greatest consideration in or about a place of public entertainment.

The actual routine of this refrigerating operation is as follows: The CO_2 is drawn from the evaporating-tanks and compressed. It is then passed into the cooling-tank, when at a temperature of about 48deg. F. it assumes the liquid form. From these condensing-tanks, which are cooled by circulating water, the liquid carbon anhydride is evaporated in two other large tanks through pipes in which the brine is circulated. The actual temperature in these evaporating-tanks was 17deg. F. when our representative visited the engine-room. The brine is thus cooled; but it will be noticed the carbonic anhydride is only used in the engine-room, the brine being the medium for cooling the ice floor by conduction.

In this installation the whole of the steam used in the various engines is condensed, and for this a large volume of cold water is required to absorb the heat of the steam, as well as to cool the gas in the carbonic-anhydride condensers. As this amount of water, if taken from the water company's mains, would be a matter of great expense, the directors decided to sink a well into the deep chalk to ensure a large supply of pure water. This well has been sunk at the far end of the engine-room to a depth of nearly 400ft. from ground level, the work being carried out by Messrs. Thos. Tilley and Sons, of Walbrook. The deep-well pump, which is capable of delivering upwards of 5,000 gallons per hour, was also supplied and erected by the same firm. This pump is driven by belt from a line shaft running overhead, and this shaft also drives the brine and water service pumps.

All the water delivered by the deep-well pump is first passed through the carbonic-anhydride condensers, where it is warmed through absorbing the heat from the compressed gas delivered into these condensers from the main refrigerating engines. Having passed through these condensers, part of the water is used in the main engine steam-condensers and for feeding the boilers, and part for the electric light engine condensers, the remainder being pumped to tanks on the roof for the general service of the building.

The condenser for the electric light and auxiliary engine is of the type known as an evaporator-condenser, and was supplied and erected by Messrs. T. Ledward and Co., of Queen Victoria-street. The pipes to this condenser are so arranged that the exhaust steam from the electric light and auxiliary engines may be turned into the condensers of the main refrigerating engines, and *vice versâ*, in the case of any breakdown.

The contract for the electric lighting machinery was placed with Messrs. Crompton and Co., Limited. Altogether, the lighting arrangements comprise the use of some hundreds of incandescent lamps, and 26 arcs, which are supplied with current by two 30-unit shunt-wound dynamos, driven with belts by two 56-i.h.p. vertical compound-condensing Sissons steam-engines, which take steam from the same boilers as the refrigerating plant.

Some interest is attached to the method of wiring that has been adopted—namely, Mavor and Coulson's concentric system, which is the subject of a paper now under consideration at the Institution of Electrical Engineers.

The floor and the whole of the machinery have been carried out to the designs and under the superintendence of the company's consulting engineers, Messrs. A. H. Tyler and J. S. E. de Vesian, A.M.I.C.E.; the company's consulting electrical engineer being Mr. C. Orme Bastian.

THE BERRENBERG METALLIC VACUUM PUMP.

It has been repeatedly asserted that the invention of the Sprengel pump brought the incandescent lamp within the range of possibility. With the highest vacuum previously attainable the carbon filaments would not last more than a few hours. As soon as the incandescent lamp was found to be a commercial possibility and a success, many inventors strove to perfect the mechanical pump as a more rapid means of exhausting the vast number of lamps required All the first attempts in this direction ended in failure, and it became almost a foregone conclusion that mechanical pumps were useless except to exhaust the bulk of the air from the bulbs before flashing the filament, and again before connecting them to the mercury-pumps. One of the early workers in this field did not, however, accept the general con

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clusion. We refer to Mr. A. Berrenberg, of Boston, who commenced his attempts to build a satisfactory pump in 1885. By gradual improvements, he succeeded in 1888 in producing a sufficiently good vacuum by mechanical means as to attract general attention.

This pump was capable of making a vacuum up to the height of the barometer and of maintaining it. But as some kind of a fluid had to be used, it was found that the vapour from this fluid destroyed the lamp. This induced Mr. Berrenberg to design another pump, and it was constructed in such a way that this vapour could not enter the lamps. This second pump was successfully put to work in April, 1890, and was described in the issue of the *Electrical World* for the 26th of that month. The author there says: "The perfection of the work depends upon the radical departure from the mechanism of the old air-pump. This departure is simple in principle, and the reason for its effectiveness is plain. The device adopted is of forming a vacuum jacket around the working cylinder, so that whatever leaks in around the other side of the box (which is closed with oil, as in ordinary air-pumps) is promptly pumped out by the subsidiary cylinder. The difference of pressure, therefore, tending to cause leaks in the joints and valves of the working cylinder can be reduced to a quantity almost negligible, and the leakage almost disappears." This pump was used in America from that date up to the present time, but the lamp patents tended to restrict its universal application. In the meanwhile the inventor continued to make improvements which are all included in the pump which is now erected at 4, Huggin-lane, Queen Victoria-street, E.C., and of which we are able to give the three illustrations herewith.

The advantages of a good vacuum are now generally understood, and the fact is recognised that the Sprengel pump will give good results. The only consideration is that valuable time is taken to produce the best results, and hence the vacuum in a commercial lamp is not as a rule equal to that which would be attained with unlimited time. Even as it is, the cost of exhausting the lamps forms a fairly large proportion of the total cost of the lamp. Another point in which advantage is gained by the mechanical pump is in the blackening of the lamp globes after use.

Prof. B. F. Thomas, in his paper communicated in 1892 to the American Institute of Electrical Engineers on the test of a large series of different makes of lamps, says: "When the sorting and grading of the blackened lamps was satisfactorily completed, it was remarked that the two lots which were least blackened were of the makes which are advertised as exhausted by mechanical pumps. That they should both be so much alike in blackening, and both only one-half as much blackened as the least blackened of the mercurially-exhausted lamps is, to say the least, worthy of notice. It is, of course, not established that the observed freedom from blackening is due to the absence of mercury vapour in the lamp, as the makers claim, but if investigation should establish the claim the mercury-pump will probably become once more a laboratory instrument."

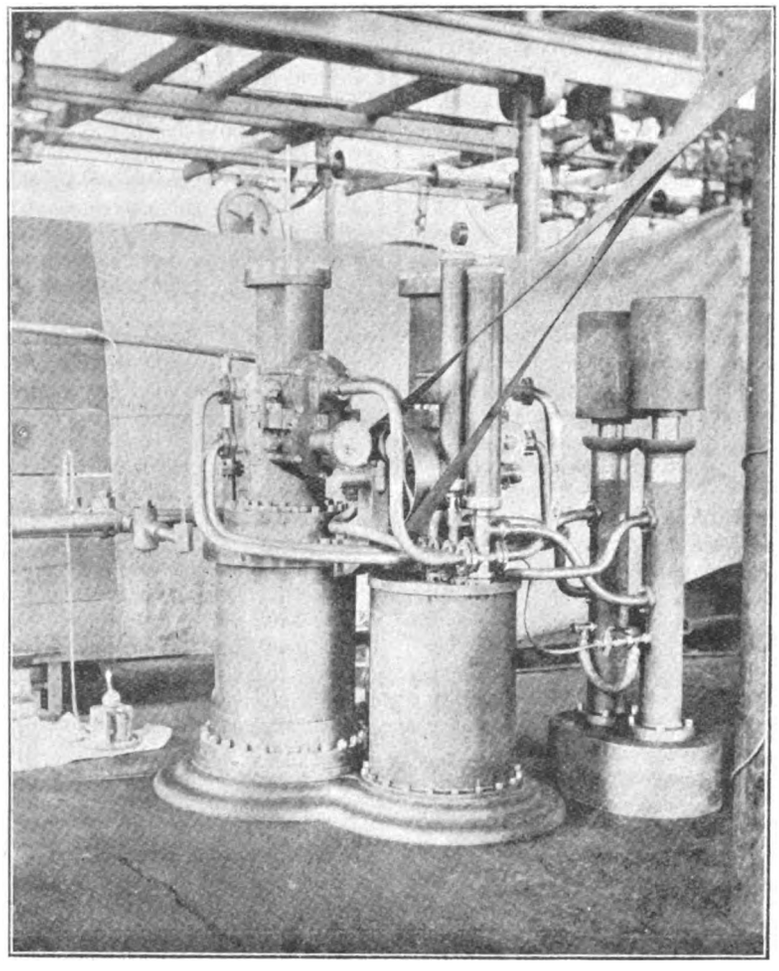

FIG. 1.—Perspective View of the Berrenberg Metallic Vacuum Pump.

The percentages of the maximum blackening observed in the lamps tested by Prof. Thomas ranged as follows: 10, 12½, 25, 28, 30, 32, 35, 42, 45, 50, 75, and 100 per cent. The first two—*i.e.*, 10 per cent. and 12½ per cent.—were observed in mechanically exhausted lamps. The mechanically exhausted lamps were treated by Mr. Berrenberg's pumps.

Leaving these historically interesting facts, the present pump is shown in perspective in Fig. 1, while Fig. 2 shows an elevation, and Fig. 3 a section through the pump. The chief difference between this machine and the pump of 1890 lies in the fact that the motion of the pump pistons is now effected hydraulically instead of by cranks, as in the older types. With air-pumps intended to produce a highly attenuated vacuum, it follows that the end clearances must be reduced to as nearly an actual fit as possible. For this reason the ends of the cylinders and piston are coned and ground to absolutely the same contour. It is then impossible to use the common reciprocating gear, and

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the requisite flexibility was in the older pumps obtained by a compressible connecting rod. It is found, however, that fluid pressure is both more convenient, as also more certain in effect. In the section (Fig. 3) the upper two cylinders form the hydraulic mechanism for moving the two concentric pistons of the air-pump. As will be seen, the larger piston forms the cylinders for the inner piston. The action of the pump is as follows, commencing from the position shown: The two pistons move up together, and thus the opening from the lamp main is uncovered by the large piston. The inner piston, travelling through a longer stroke, delivers air abstracted from the lamp on the previous up stroke into the space above the piston. The outer piston previously delivers a certain amount into the space above the cylinder through the valves shown. This space is connected to the preliminary vacuum pump, and hence no increase of pressure is obtained. In fact, there is no atmospheric pressure anywhere within the air-pump. The fluid used in the upper cylinders for working the pump is a non-volatile oil. The force pump for maintaining the pressure on it is shown in the foreground in Figs. 1 and 2. The two accumulators shown in Fig. 1 are used to keep the pressure constant and to prevent shock at the end of the stroke. The great feature in the construction of these pumps

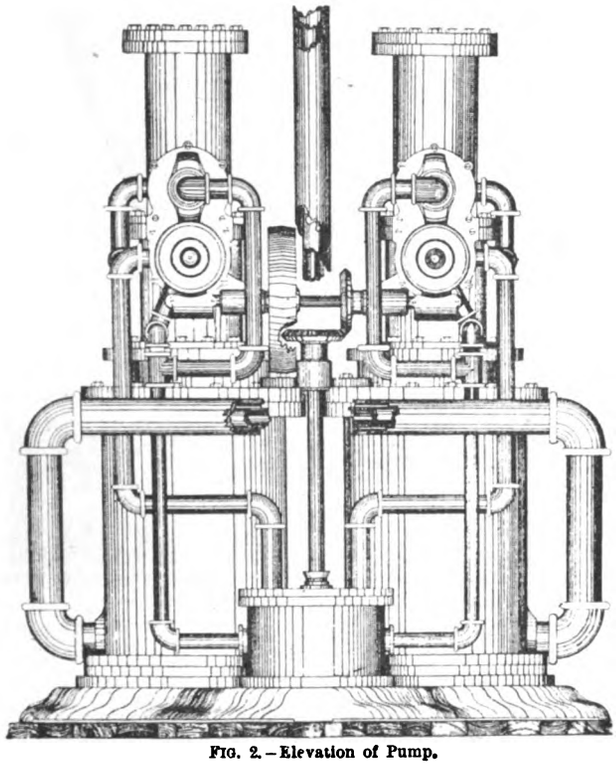

FIG. 2.—Elevation of Pump.

and the whole system is the excellence of the mechanical construction. The pistons and cylinders are made of welded steel rings, and then hammered out to the required diameter to ensure uniform density and freedom from air-holes. The work is then accurately turned on a lathe, the finish being given by an emery-wheel to ensure truth in every part. The other details of the pump will be gathered from the illustration.

Coming now to the practical work done by the pump in Huggin-lane as verified by us, the pump is connected to a duplex system of pipes, one branch of which is supposed to be exhausting, while lamps to be treated are being attached to the other branch. These pipes can be partly seen in Fig. 1. At Huggin-lane only one branch is erected, owing to the limited space sufficient for test purposes. It consists of one main pipe and eight side tubes, each controlled by a valve. Each side tube has sockets provided for four main lamp connections. The junction in Fig. 1 only shows one such socket. These sockets are tapered to receive glass plugs with cocks, to which are blown a series of lamps. The whole of the glass plugs are emery ground to an exact taper, so that any plug will make an absolutely air-tight connection with any socket. The whole of the tubes connected to the pump are lagged by the same non-volatile oil that is used in the pump. This is done by surrounding them by a second system of steel pipes, which, of course, is the one seen in the figure. The intervening space is then filled with the liquid.

The equivalent number of 16-c.p. lamps connected in our presence was 265. These were roughly exhausted by an ordinary air-pump and then connected to the final pump. In six minutes the McLeod gauge showed that $\frac{1}{50,000}$th of the atmospheric pressure remained inside the bulbs. The bubble left in an ordinary-sized lamp bulb when filled with mercury was then of the same size as that in a lamp exhausted by mercurial pumps, which Mr. Berrenberg assured us was about the best he has found.

To check this, we brought a commercial lamp at once from an independent source, and on breaking it under mercury found the residual bubble to be considerably larger. The reading on the McLeod gauge at this point was 10mm. After 20 minutes this value was reduced to about 1mm., corresponding to a pressure of $\frac{1}{500,000}$th of an atmosphere. As will be gathered from the above, this is 10 times better than that in the ordinary lamps exhausted by mercury-pumps. Thus, both in speed and quality this pump gives most excellent results, and the inventor is to be congratulated on the success which has followed the long and arduous labours. The perfect interchangeability

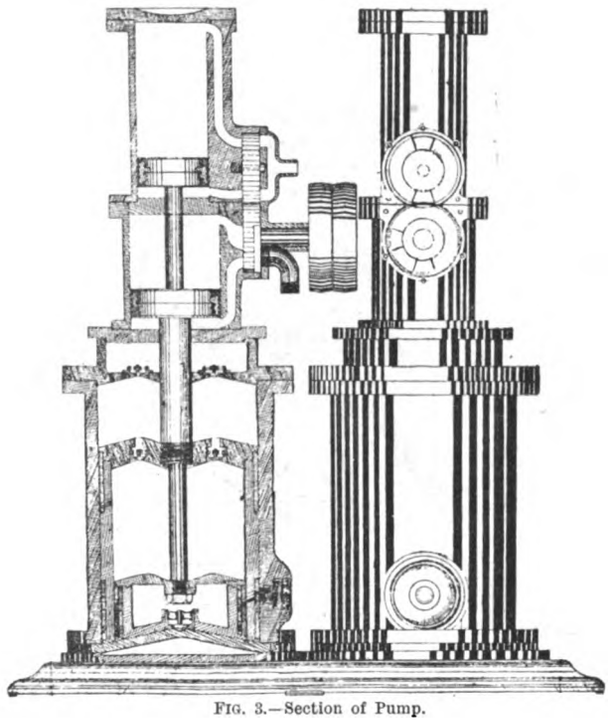

FIG. 3.—Section of Pump.

of parts must be seen to be believed. The fact that the system of pipes and valves shows no appreciable leakage in 48 hours is a proof of the good results obtained. We shall await with interest the results of the attempt to get English lamp manufacturers to take up this method of exhausting their lamps.

THE GENERAL ELECTRIC COMPANY'S 1896 CATALOGUE.

The new edition of this company's price-lists is bound up in a handsome medium quarto volume, containing about 1,000 pages and some thousands of illustrations, the various articles listed comprising practically every article required in the equipment and use of the now numerous branches of electrical science and the many practical applications resulting therefrom. Thus the articles listed vary from a countersunk iron screw up to a complete electric dog-cart with silk fittings, and, again, down from an electric piano, which we presume is musical, to an electric bell at 2s. 9d., which decidedly is not. The range of subjects has been met to a certain extent by subdividing the matter into eight sections, although in certain cases it

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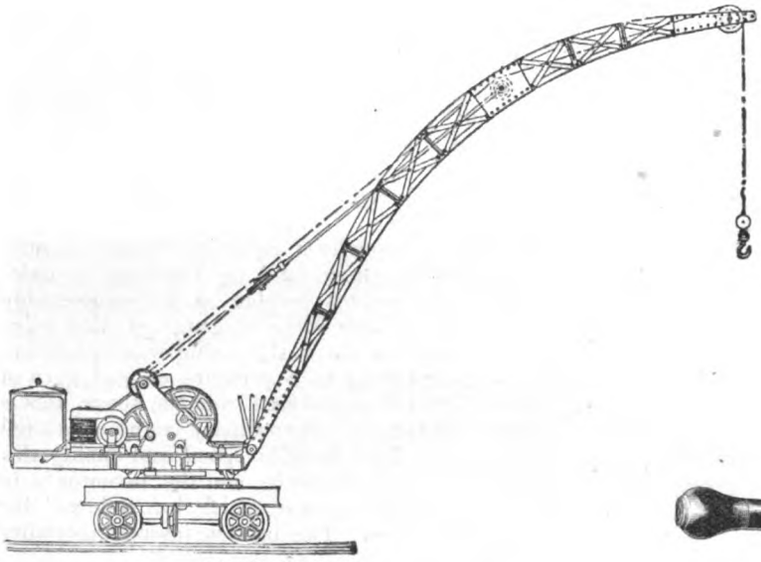
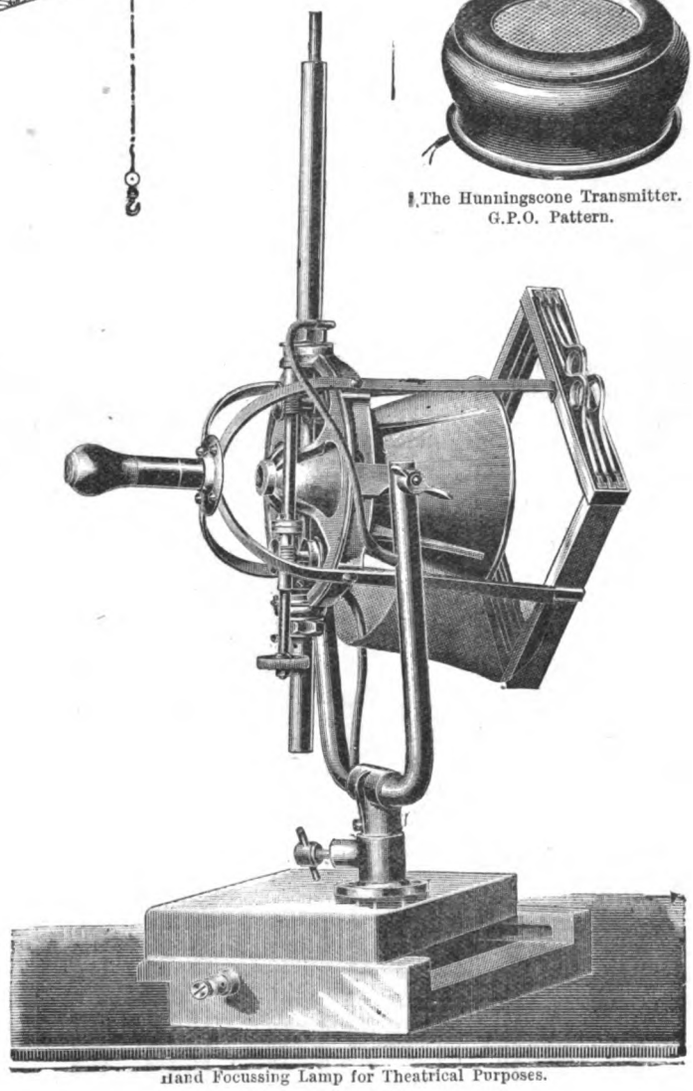
is not easy to classify correctly. Thus the electric piano mentioned above is placed in the heating and cooking section, and is sandwiched in the index between an electric oven and an electric saucepan. We are also glad to note that now only certain types of transformers are heating apparatus. In the early days nearly every transformer was a capable heater of itself and its surroundings.

The section A, dealing with electric plant, contains 79 pages and 105 illustrations. It comprises a full price-list of engines (steam, gas, and petroleum), boilers, turbines, waterwheels, steam dynamo sets, dynamos, accumulators, transformers, alternating-current and multiphase apparatus and accessories for transmission of power, electric welding, and central-station stores, meters, instruments, etc.

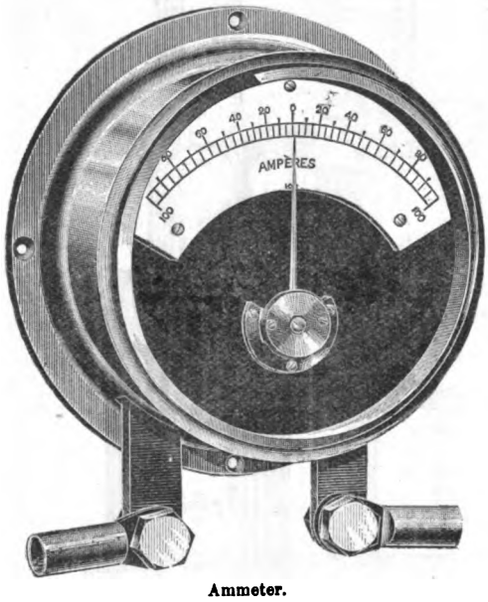


Electric Jib Crane.

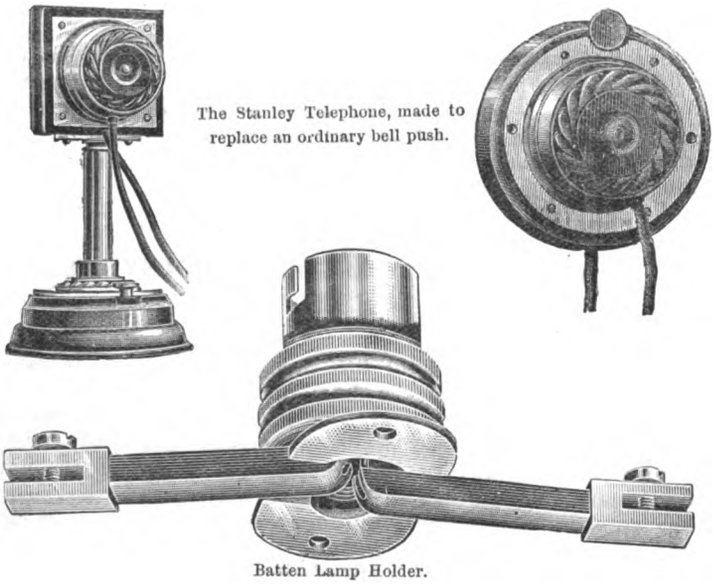
The Hunningscone Transmitter. G.P.O. Pattern.



Hand Focussing Lamp for Theatrical Purposes.



Ammeter.



The Stanley Telephone, made to replace an ordinary bell push.

Batten Lamp Holder.

Electrical Dog Cart.

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The next section refers mainly to house wiring and the thousand different articles directly connected therewith, such as cables, wires, lamps, switches, fuses, casing, tubing, etc. The stage lamp illustrated below comes in this section. It is a hand-feed focussing lamp, with arrangements in the front for interposing coloured glass before the beam. This class of lamp is being used largely in London theatres. The catalogue also shows that the company stock accessories for wiring on any system, whether casing, tubing, or concentric. The batten holder for theatre-lighting purposes is another new item in this issue.

Section K (telephones and telegraph) covers the ground of practical telephony up to the most recent and approved inventions. The "Hunningscone" telephone is shown, as are also the Stanley and other telephones, both in detail parts and also as arranged in complete systems. The numerous diagrams for wiring and installing telephones and estimating costs given here enables even a novice to understand a telephone installation.

Section M, on motors, is devoted to direct and alternating current motors and their application. There is in this section necessarily a very full explanatory text in which the principle, construction, action, and efficiency of the electric motor are explained by the aid of excellent diagrams and tables. The constructive portion also includes directions for installing electromotor plant; direct-current, alternating, three-phase and polyphase motors of various powers are tabulated and described; and we believe that this is the first English catalogue to publish the prices of three-phase plants. The various appliances for which motors can be used are described, and many illustrations are given. The other sections are headed "Electric Bells, etc.," "Medical Apparatus," which includes patient (*sic*) batteries, "Fixtures and Glassware," and "Cooking and Heating." This last section, although small at present, is expected to do great things for the central-station engineer in the future. The general get-up of the catalogue is good, and the index appears to be accurate and convenient.

In this catalogue one great advantage is that each article is illustrated by an excellent and clear woodcut, which, in almost every instance, has been made to a uniform scale of reduction. This enables one to form a very accurate idea of the size of an article, and is particularly useful in selecting electric light fittings. The prices are placed under every article, which enables one quickly to ascertain the price without having to turn back to ponderous lists.

The technical information given in the appendix and elsewhere is, on the whole, correct and very useful; but the comparison between the cost of gas and electric lighting in small installations is misleading, as the cost of labour is omitted. We must congratulate the General Electric Company on their production, and trust that the return will be in proportion to cost incurred.

We note that the nominal charge for this large volume is 10s., but that the money is refunded if orders are obtained through it.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE UNIQUE SWITCH.

SIR,—In conversation with some of my clients I learn that someone is spreading a report in the trade to the effect that I have given up making my "Unique" pattern switch; and I shall be much obliged if you will be kind enough to allow me to contradict this rumour in your valuable journal. It may have been originated by someone having obtained the knowledge that the "Pioneer" type of switch is still enjoying a good sale, and I have for that reason, and at the wish of some of my clients, reconstructed same, and hope in a short time to put it on the market at a popular price. But this has nothing whatever to do with the sale of the "Unique" switch, which is as good as ever.—Yours, etc., A. P. LUNDBERG.

DIVISION TABLE FOR A PHOTOMETER BAR.

For those who have to carry out photometric measurements, the table given below may prove useful. It has been compiled by Major Bagnold, R.E., to enable a draughtsman to lay out, by means of a beam compass, a scale for reading off results direct from a photometer bar of any length. In this way a great saving of time is effected when a large number of photometric measurements have to be made.

DIVISION TABLE FOR PHOTOMETER BAR.

Column I. gives ratio of light under measurement to standard light. Column II. gives fraction of whole bar measured from its middle point.

I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.
50	·3761	15·0	·2948	7·0	·2256	3·0	·1340	·80	·0279	·40	·1127
49	·3750	14·5	·2921	6·9	·2242	2·9	·1301	·79	·0295	·39	·1158
48	·3739	14·0	·2892	6·8	·2227	2·8	·1260	·78	·0310	·38	·1189
47	·3727	13·5	·2861	6·7	·2213	2·7	·1217	·77	·0326	·37	·1221
46	·3715	13·0	·2829	6·6	·2198	2·6	·1172	·76	·0342	·36	·1254
45	·3702	12·5	·2795	6·5	·2183	2·5	·1127	·75	·0358	·35	·1287
44	·3689	12·0	·2760	6·4	·2167	2·4	·1078	·74	·0375	·34	·1321
43	·3676	11·5	·2722	6·3	·2151	2·3	·1027	·73	·0391	·33	·1356
42	·3663	11·0	·2682	6·2	·2134	2·2	·0973	·72	·0409	·32	·1391
41	·3649	10·5	·2641	6·1	·2118	2·1	·0916	·71	·0426	·31	·1437
40	·3635	10·0	·2597	6·0	·2101	2·0	·0857	·70	·0444	·30	·1464
39	·3620	9·9	·2588	5·9	·2084	1·9	·0795	·69	·0462	·29	·1501
38	·3604	9·8	·2579	5·8	·2066	1·8	·0730	68	·0480	·28	·1540
37	·3588	9·7	·2570	5·7	·2048	1·7	·0659	·67	·0498	·27	·1578
36	·3571	9·6	·2560	5·6	·2029	1·6	·0582	·66	·0517	·26	·1619
35	·3554	9·5	·2550	5·5	·2010	1·5	·0500	·65	·0536	·25	·1662
34	·3536	9·4	·2540	5·4	·1991	1·4	·0412	·64	·0555	·24	·1707
33	·3517	9·3	·2530	5·3	·1972	1·3	·0317	63	·0574	·23	·1754
32	·3498	9·2	·2520	5·2	·1952	1·2	·0218	·62	·0594	·22	·1803
31	·3478	9·1	2510	5·1	·1932	1·1	·0112	·61	·0614	·21	·1854
30	·3457	9·0	·2499	5·0	·1911	1·0	·0000	·60	·0634	·20	·1908
29	·3435	8·9	2489	4·9	·1889	·99	·0012	·59	·0655	·19	·1964
28	·3413	8·8	2478	4·8	·1887	·98	·0024	58	·0676	·18	·2022
27	·3388	8·7	·2467	4·7	·1844	·97	·0037	·57	·0698	·17	·2082
26	·3363	8·6	·2456	4·6	·1821	·96	·0050	·56	·0720	·16	·2144
25	·3335	8·5	·2445	4·5	·1797	·95	·0063	·55	·0742	15	2208
24	·3306	8·4	·2424	4·4	·1773	·94	·0076	·54	·0765	·14	·2277
23	·3276	8·3	·2422	4·3	·1748	·93	·0090	·53	·0788	·13	·2349
22	·3243	8·2	·2410	4·2	·1722	·92	·0103	·52	·0811	·12	·2426
21	·3209	8·1	·2399	4·1	·1695	·91	·0117	·51	·0835	·11	·2508
20	·3172	8·0	·2386	4·0	·1667	·90	·0131	·50	·0859	·10	·2597
19·5	·3154	7·9	·2374	3·9	·1639	·89	·0145	·49	·0883	·09	·2692
19·0	·3135	7·8	·2362	3·8	·1609	·88	·0159	·48	·0908	·08	·2794
18·5	·3114	7·7	·2350	3·7	·1579	·87	·0173	·47	·0933	·07	·2905
18·0	·3093	7·6	·2337	3·6	·1547	·86	·0188	·46	·0959	·06	·3032
17·5	·3070	7·5	·2325	3·5	·1516	·85	·0203	·45	·0985	05	·3174
17·0	·2048	7·4	·2312	3·4	·1483	·84	·0218	·44	·1012	·04	·3332
16·5	·3024	7·3	·2298	3·3	·1450	·83	·0233	·43	·1040	·03	·3538
16·0	·3000	7·2	·2284	3·2	·1415	·82	·0248	·42	·1068	·02	·3791
15·5	·2974	7·1	·2270	3·1	·1379	·81	·0263	·41	·1198	·01	·4091

WHAT, WHEN, AND WHERE.

Society of Arts.

January 15, 8 p.m.—At John-street, Adelphi. "The Making a Great University for London," by Prof. Silvanus P. Thompson.

Royal Astronomical Society.

January 10, 8 p.m.—Burlington House, W. Meeting.

Junior Engineering Society.

January 10, 8 p.m.—Westminster Palace Hotel, S.W. "Gas-Engines and Hot-Air Motors," by Prof. T. Houston Bear.

Institution of Electrical Engineers.

January 16, 8 p.m.—At the Institution of Civil Engineers, 25, Great George-street, Westminster. Presentation of Premiums, Presidential Address by Dr. John Hopkinson, M A., F.R S.

Royal Meteorological Society.

January 15, 7.30 p.m.—At the Institution of Civil Engineers, 25, Great George street, Westminster. Ordinary meeting and annual general meeting. The report of the council will be read, the election of officers and council for ensuing year will take place, and the president (Mr. R. Inwards, F.R.A S) will deliver an address on "Meteorological Observatories."

Institution of Civil Engineers.

January 14.—At 25, Great George street, Westminster, S.W. Paper on 'The Sanitary Works of Buenos Ayres: Sewerage, Drainage, and Water Supply," by the Hon. R. C. Parsons, M.A., M.I.C.E.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XV. of new series of "THE ELECTRICAL ENGINEER" can b had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

A LESSON OF THE MOMENT.

Such is the headline to a letter of Mr. George Baden-Powell given in the *Times* of Tuesday last. Mr. Powell writes as follows:

"Sir,—At the moment we are all of us painfully anxious for prompt and unadulterated telegraphic news from South Africa, from Venezuela, and from other places where there is trouble. Still greater would be our anxiety and our need in time of actual war. The public will do well to bear in mind the present condition of our telegraphic connections.

"In regard to South Africa, the Aden-Zanzibar cable happens to have broken at an inopportune moment; considerable delay occurs on the West Coast route. But all these messages, as well as those to and from the Ashanti expedition, have to pass through foreign territory.

"Again, telegraphic connection with British Guiana, with all our Western Indian possessions, with our fleet in the West Indies, is maintained by means of landlines across Cuba and across the United States, lines subject to the necessities of local combatants or others who might be hostile to us.

"The remedy is simple—viz., to hasten the inevitable completion of two projected all-British direct cables. It is an axiom of to-day that submarine cables, made and laid with all the latest appliances, are certain to pay for commercial purposes; for State and strategic purposes they are indispensable.

"It is therefore to be hoped that in these moments of stress the public will read the lesson aright and see to it that the responsible authorities arrange to provide the two lines of cable communication which our empire may so urgently need in the future—viz., the shorter line from Bermuda to Jamaica and the longer line from Vancouver to Australia, with its continuation to Mauritius and South Africa.

"We shall thus obtain alternative and all-British means of communicating between all oversea points of the empire, invaluable alike for the commerce and security of all its parts."

The strategic value of cable communication with our Colonial Empire under the complete control of this country is what we have been arguing for years. From a purely commercial standpoint, there is much to be said in favour of numerous loops connecting port to port; but may it not be that even commercially inter-Imperial connections have a real value? The statistics that are brought forward by interested parties are of little use in this controversy, because, like the Chinaman who had never tasted roast pig, we know so little of the unknown—and the other statistics are unknown. Cables are now very much like railways with main and branch lines, the main line being fed largely by business from the branches. One of the purely commercial arguments against the Pacific line has been that it is, or, rather, would be, wholly a main line, and that there would not be enough traffic to make it pay. We do not believe a word of this argument, for, in the first place, all the American traffic to the East now has to come *viâ* Europe and traverse various lines to its disadvantage. If there was a Pacific cable, all the American traffic to Australasia would go by it, and we fancy very much of the European traffic would follow suit. We hope to live to see the Pacific line, and do not mind prophesying that the moment it begins to work—nay, before it begins to work—the present cable ring will find the existing tariffs are far too high, and will make a considerable reduction. We venture to say the ring has never worked its lines economically—it has never tried to do so; its tariffs have always been excessive, and its monopoly has neither been worked for the benefit of shareholders or clients, but solely in the interests of an inner ring. If it were otherwise, we should be the last to condemn the policy of business first and strategy after. City men have not to trouble about strategic concerns—they have to earn money,

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and part of the money they earn goes to pay specialists to consider strategy. The various Governments concerned, then, are in our estimation more to blame for not combining the two things when agreeing to pay subsidies. The Governments may be said to have, in the first place, to consider Imperial wants; and, secondly, commercial wants. The fact is, that the former very largely include the latter, and most unmistakeably Imperial wants ought to consider as imperative the means of communicating with our Colonies without the cognisance of foreign nations. Thus, if subsidies are to be paid at all, they should be paid to such concerns as can be controlled upon our own territory. Our advice would be for all Colonies and the mother country to give notice that subsidies would be withdrawn from the companies not complying with these conditions, and transferred to the companies complying with them. Most subsidies are terminable at the end of a certain number of years; let them terminate so far as the present recipients are concerned, and be handed over to those who perform similar work wholly within our own territory.

BUSINESS DURING 1895

(Continued from page 18).

J. E. H. ANDREW AND Co. write: "We find on referring to our books that during 1895 we have supplied a total of about 1,200 effective horse-power for generating the electric current, which would be about equal to 12,000 16-c.p. lamps. Among the great number of private and public installations for which we have supplied 'Stockport' gas-engines as the motive power during 1895 we find it somewhat perplexing to give examples, but we may mention that among public institutions supplied during the year are: 9 e.h.p., Sydney University; 9 e.h.p., Theatre Royal, Merthyr Tydfil; 13 e.h.p., St. George's Hall, Newcastle-on-Tyne; 19 e.h.p., Chadwick Memorial Schools, Newcastle-on-Tyne; 30 e.h.p., Belfast Art and Industrial Exhibition (sold *Northern Whig* newspaper offices); 42 e.h.p., *Citizen* Office, Glasgow (Messrs. Jas. Hedderwick and Sons); 42 e.h.p., Temple Press, Limited, Rosebery-avenue, London, E.C.); 7 e.h.p., Column Printing Telegraph Syndicate, London (charging accumulators), hotels, etc.; 30 e.h.p., Grand Central Hotel, Belfast (J. H. Greenhill, Esq., consulting engineer); 35 e.h.p., Three Nuns Hotel, Aldgate, London, E.C.; 10 e.h.p., Ridgway Hotel, Douglas, Isle of Man; 24 e.h.p., Junior Reform Club, Liverpool (Mather and Platt, Limited, consulting engineers); central station, 120 e.h.p., Brookline Gaslight Company, Boston, Mass., U.S.A. Co-operative stores: 30 e.h.p. (two engines 15 e.h.p. each), Home and Colonial Stores, Finsbury; 22 e.h.p., Nelson Co-operative Wholesale Society, Limited, Nelson, Lancs. Private residential installations: Dr. Hopkinson (of Messrs. Mather and Platt, Limited), Oakleigh, Timperley, Cheshire; Dr. Ballantyne, Darwen; Alf. Benn, Esq., Upper Syke, Clayton, near Bradford, Yorks; Messrs. Ernest Scott and Mountain, Newcastle-on-Tyne, for private residence; J. T. Sandell, Esq., 213, Selhurst-road, South Norwood; Mr. N. Kilvert, Brooklands-road, Brooklands; and T. P. Petrocokino, Esq., Sedgeley Park, Higher Broughton. Messrs. Mather and Platt were the consulting engineers in regard to the last two installations. All the foregoing have been supplied with engines for driving electrical plant, and we may say that we have also had engines at several exhibitions, shows, etc., during the year driving direct lighting. We have a good number of orders on hand at the present time, and we are very hopeful as to the prospects of 1896; and with special reference to gas-engines for electric lighting we are pleased to see that the use of them is decidedly on the increase, and we are of opinion that the gas-engine will in the future be more often used for central-station work. We may say that in addition to the engines delivered in the United Kingdom we have exported several large engines and a good number of smaller ones for driving dynamos, etc., on the Continent, which are giving great satisfaction. We are very pleased to be able to say that up to the present time we have turned out every year an increased number of engines, and a higher average horse-power; and from the orders we have in hand at present, and enquiries received, etc., we have every reason to hope that at the end of the present year we shall have again considerably increased our output of engines for electric work."

THE BRITISH INSULATED WIRE COMPANY say: "We have carried out contracts for the following electric supply works: County of London and Brush Provincial Company, Limited, St. Luke's and Clerkenwell, London Electric Supply Corporation, Notting Hill Electric Lighting Company, Limited; further extensions to the City of London Electric Light Company, Limited, Aberdeen, Altrincham, Blackpool, Bolton, Bournemouth, Brighton, Bristol, Cambridge, Dover, Edinburgh, Hanley, Huddersfield, Leicester, Oldham, Portsmouth, Preston, Salford, Sheffield, Southport, Worcester, Yarmouth, Sunderland, as well as the tramway work at Bristol, and the high-tension mains for the tramways at Dublin, and telephone cables for the English Government National Telephone Company. As regards the new year, we have a large quantity of work before us—contracts at Shoreditch, St. Helens, Wakefield, Harrogate, and other towns, besides extensions at many other places. A very large extension of the factory is in hand and nearing completion."

MESSRS. BROWETT, LINDLEY, AND Co. have very much increased their output of engines for electric lighting and other purposes during the past year; in fact, it has been the largest since they commenced business. To meet the increased demands a good many new machine tools have been installed, and others are now in progress. Their standard vertical electric lighting engines, chiefly for direct driving and use on shipboard, have furnished the firm with the bulk of their orders, something over 100 engines having been supplied. They have also had during the year a fair share of heavier and central-station work, amongst which may be mentioned the completion of the Salford electric lighting station contract, a 250-h.p. engine for Derby extension, and two 220-h.p. engines for Ealing extension; also three 350-h.p. and one 250-h.p. engines of the vertical compound type for the British Plate Glass Company, St. Helens, two of which are now installed, and the other two nearing completion. Also several engines from 100 h.p. to 200 h.p. have been delivered during the year, including two for Spain, one for France, two for Russia, and one for the extension of the lighting of Messrs. R. Haworth and Co.'s mill. The firm have also supplied the whole of the pipe work and the surface-condensing plant for the electric generating station of the Dublin electric trams, and also a surface-condensing plant to the Southport Corporation for their electric lighting

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station. During the year also, two of their special horizontal high-speed engines have been supplied to the General Traction Company for driving the generators at the Coventry tramway station; also coupled electric light plants for the Waterloo and City Railway Company, London, and the Ravenhead Plate Glass Works, St. Helens. The company also report very satisfactory prospects for the new year; they already have several good orders to commence work with, and there is every prospect of another very busy year.

DRAKE AND GORHAM report that during the past year the firm have made the usual progress, and it has been found necessary to enlarge the offices to accommodate the additional staff required, as well as to increase the showrooms of the firm's specialities and fittings. The branch at Manchester has been exceedingly busy, and arrangements are being made for opening another branch at Glasgow to facilitate the carrying out of the Scotch business. Among the more important of the country installations in hand during the year may be mentioned: Crewe Hall, for the Right Hon. the Earl of Crewe, 550 lights (steam plant); Windlestone Hall, for Sir William Eden, 300 lights (steam power); Sir Williams Farmers, near Ascot, oil-engine; Major Kearsley, Nantwich; W. H. Oakley, Esq.; A. H. Brown, Esq., M.P., near Dorking, steam; J. Murray Johnson, Esq.; F. Bower, Esq., Farningham, water-turbine; Captain Ormrod, steam; W. Drury Lowe; Herbert Strutt, Esq., Belper, water-turbine; C. C. Wyllie, Esq., Esher, oil-engine: J. Van Raalte, Esq.; J. Cannon, Esq.; E. H. Hills, Esq.; Captain Boothby; W. Lancaster, Esq., etc. The following are some of the town houses: the Right Hon. Marquis of Lansdowne, Secretary of State for War; His Grace the Duke of Montrose, Pont-street; Devonshire House extensions; the Right Hon. Lord Wynford; Forbes Leith, Esq.; Sir Richard Quain, F.R.S., etc.; Sir William Power; Prof. Kennedy; Miss Talbot; Charles Lucas, Esq.; Major the Hon. E. R. Bourke; Admiral Bowden Smith; the Hon. Mrs. Hay; Claude Hay, Esq.; A. Strickland, sen., Esq.; A. Strickland, jun., Esq.; Colonel Gascoigne; G. D. Faber, Esq; J. S. Buckingham, Esq.; J. Beck, Esq.; L. Tatham, Esq.; A. G. Duff, Esq.; W. L. Macnaughten, Esq.; Mrs. Sidney Whatson. Among the important public buildings, etc., the firm have in hand the whole of the generating plant for the Prudential Assurance Company, comprising two sets of 250 h.p. each, one set of 75 h.p., one set of 50 h.p.; also the Stafford Technical Schools, 1,100 lights: Balliol College, 370 lights; Convalescent Home, Littlehampton, 230 lights; Stafford County Infirmary, 230 lights; Cancer Hospital, 320 lights; Lancaster Infirmary, 240 lights; St. Paul's, Deptford, 110 lights; St. Michael's Church, Chester-square, 200 lights; Manchester Corporation gas-stove showrooms; University Galleries, additional arcs and incandescents; Council of Foreign Bondholders; South-Eastern Railway Company's Offices, Tunbridge Wells; North-Eastern Railway Company's Offices; Messrs. S. Allsopp and Son's Offices, etc. The factory of the Jandus Arc Lamp and Electric Company has been organised, and special machinery made for turning out every separate part, so that the Jandus arc lamp is now being put on the market upon a thoroughly commercial basis. These lamps burn from 120 to 200 hours, according to the current for which they are constructed. The "D.P. battery" business during the year has been turned into a private company, the directors being Mr. Claude Johnson (of Messrs. Johnson and Phillips), Mr. Bernard M. Drake, and Mr. Gorham. The sale of the earthing device has considerably increased, and 3,500 of these are now in daily use. No single case is known to have occurred of the apparatus having failed to effect its purpose.

THE ELECTRICAL COMPANY say: "In the arc lamp department the firm has been exceptionally busy this season, and some very large contracts have been secured for their famous 'Luna' arc lamps, including a good number from her Majesty's Government. A new self-focussing type of lamp has recently been added, which, owing to its high quality and exceedingly low price, well merits the reception it has already received. Whether for direct or alternating current, the length of the lamp's overall is very short. It is differentially wound, and supplied at a price at which shunt lamps are usually figured. Very effective ornamental lanterns of polished copper or brass, relieved with nickelled or steel bronzed parts, can be supplied for these lamps. The company claims to keep the most extensive stock of any single firm in England, both in arc lamps of all kinds and in their well-known accessories, such as resistances, choking coils, reducing transformers, winches, etc. The 'E.C.' incandescent lamp has again maintained its prestige throughout the season, and some very important contracts have been secured, including those of the large steamship companies and central stations. A new bayonet socket has been most successfully introduced, in which the insulation is maintained under any conditions. The leading-in wires do not touch the cement, which, by the way, consists of a new material, possessing exceptional tenacity. The brass contact plates are cast in with the vitrite end plate, and have ventilation holes specially provided, allowing the air to pass freely, and thereby keeping the interior dry. The E.C. lampholder, with key, is claimed to have been the first one having a combination of pistons with so-called 'A' terminals with the now universally adopted spring contact switch, and a very large trade has been the result since its introduction. It is now announced that a new holder will shortly be introduced with a new kind of patented spring contact, having all the advantages of the old type of holder with some additions. The well-known Royal switches are specified in many of the most important installations. This type of switch is particularly adapted for a variety of purposes, such as staircase-lighting, electroliers, corridor-lighting, etc. Among the measuring apparatus, the well-known 'Ready' testing sets are commanding an ever-increasing sale. The 'Dolivo' ammeters and voltmeters have maintained the high esteem in which they have stood now for quite a number of years. A new high-tension electrostatic voltmeter will shortly be added to the long list of this class of instruments. A new department has this season been added for electrical heating and cooking apparatus, and to judge by the most gratifying results already obtained, these appliances have by their own merits established a high rank for themselves, and bid fair to become most formidable rivals to their somewhat longer established competitors. The firm are now on the point of issuing a full and complete catalogue of all their goods and specialities in book form, which will shortly be distributed to the trade."

JOHNSON AND PHILLIPS write: "During the past year all the departments of this firm have been uniformly busy. The manufacture of alternators, dynamos, transformers, and central-station accessories has surpassed that of previous years. The

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firm have been very busy on several large contracts, which include transmission of power plants for South Africa, alternators for the St. Helens Corporation, and the station plant for the Cape Town Electric Lighting Company. Orders for transformers continue to pour in, and the firm have more transformers of their manufacture on circuit in this country than any other manufacturers. Several of 100-kilowatts are now being constructed, and the sizes on order vary from this to half a kilowatt. The cable machinery department has been very busy on stranding, cable-making, and wire-covering machines, both for this country and abroad, and have also had in hand the picking-up and paying-out machinery, accessories, and stores forming the complete equipment for the Japanese Government's cable steamer. The arc lamp department has been kept exceptionally full of orders, especially during the latter part of the year, and nearly all the corporation contracts of the year have been secured—viz., those for Portsmouth, Brighton, Taunton, South Shields, and Edinburgh; also for the lighting of Johannesburg. The total orders are much in excess of the previous year. The new type of Brockie-Pell lamp introduced at the beginning of last year is rapidly gaining favour, and the pattern is the best yet devised. The firm are now putting down special tools for still quicker production. An exceedingly large business has also been done in carbons. The cable department has been chiefly occupied during the year with the manufacture of vulcanised rubber cables for wiring purposes and underground use. High-tension concentric mains have been completed in connection with the lighting of London, Walsall, and Malta, as well as a large quantity of single mains for various towns at home and abroad. The Brooks oil-insulated cables have been supplied for the wiring of the Glasgow Harbour tunnels, the wires being insulated with oil right up to the incandescent lampholder. It is interesting to note that the use of this system for this class of work has been a great success, and the firm looks forward to see during the present year a number of mines, tunnels, and underground railway stations lighted on this principle. In the meter department every effort has been necessary to meet the steadily-increasing demand, and standard designs for all sizes from 5 to 1,000 amperes have been prepared, in addition to those in use at the beginning of the year. From these designs instruments of all sizes have been stocked and sold, and the orders continually repeated testify to the satisfaction they are giving. Very extensive additions to the instrument shops have been made for rapidly and accurately testing these instruments. The plant put down early in the year has been kept fully occupied, and should the sales continue to increase at the same rate, as the firm has every reason to believe they will, further additions will very shortly be needed. On the whole the firm have only to congratulate themselves on the work they have secured and executed during the year, and the outlook for 1896 is regarded as extremely hopeful."

MR. LUNDBERG writes: "Business has kept well up to the usual standard, and a great improvement on that done during 1894. My various specialities continue to go well—*e.g.*, the 'Unique' switch has nearly reached a sale of 90,000 from my works alone, and is being made and sold by my licensees on the Continent. Several novelties are in hand, and I hope will be on the market shortly. Continental competition has been successfully met, and some satisfaction is obtained by sending fair quantities of goods to Germany and other important Continental countries. Business with the Colonies and other countries abroad has considerably increased, particularly Australasia, South Africa, India, and South America, and my prospects for 1896 in this direction are very satisfactory."

WALSALL ELECTRICAL COMPANY say: "During the last 12 months we have been extremely busy in all our departments. The output of our arc lamps, instruments, switchboards, motors, etc., has greatly exceeded that of any other year. The workshops have been running from early morning until late at night in order to execute customers' orders, and we have found it necessary to increase our plant and machinery to cope with the demand. We have also made improvements in our various manufactures, keeping well in touch with everything that is up to date. We have completed a number of large and important lighting installation contracts, both for private houses and public buildings. A great many of the plants for the private houses have included engines, dynamos, and storage. We have just commenced a contract within the neighbourhood of Birmingham of about 500 lamps, which includes engines, dynamo, and switchboard. We have also just finished a contract for about 250 lamps with dynamo, storage, switchboards, and have also completed the lighting-up of a large brewery with about 350 lights, including steam-engines, dynamos, motors, storage, etc., and are now finishing a contract of about 1,000 lamps, upwards of 20 motors, and about 50 arcs. Things look very bright for 1896, and we think there is every prospect of a good trade, and we have still in hand sufficient work to carry us on for some time.

HALIFAX.—Mr. T. P. Wilmshurst, the borough electrical engineer, writes: "So far as the Halifax Corporation works are concerned we have had a very successful year, and our prospects for the future are exceedingly bright. During our first 12 months' work we have connected exactly 10,000 8-c.p. lamps, and the demand is increasing. A 600-h.p. extension is now nearly completed. The financial results will be published in due course, therefore I will not dwell on them here. One of the most significant signs of the times is the concurrence of opinion that, for alternating stations at any rate, a 300-kilowatt set is not too large, and I anticipate seeing a large number of these sets at work in the near future. In the smaller alternating stations, I believe, consideration may well be bestowed on the use of a small motor-alternator set run from accumulators for the day load. I anticipate in many towns the addition of tramway generating plant to the existing electric lighting works, and in this direction is to be found the solution of the day-load problem. This question is under the consideration of my Corporation, as of many others, at the present time. Another question which deserves serious attention is the utilisation of town refuse. It appears to me this can only be relied on to supplement and not to replace a battery of coal-fired boilers and to manage the day load. Unfortunately there appears to be the difficulty that the thermal value of the refuse is least in winter, when the greatest amount of steam is required. Any well-considered scheme must, in my opinion, include a system of thermal storage. I think I echo the sentiments of many station engineers when I say that until we have before us the unbiassed statement of the actual economy gained by a large station worked in this way we shall be somewhat suspicious of the thermal value of a fuel a percentage of which consists of dead cats and tin cans. It is not solely a question of possible saving to the electricity departments, but rather of

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municipal economy generally. In other words, there may be a slight reduction of expenditure at the electricity works by using refuse, but at an increased cost to the sanitary department owing to longer cartage, involving a net loss to the town. The schemes, however, which are now under weigh will be followed with much interest."

LONDONDERRY.—The Londonderry Corporation electricity works started on May 29, 1894. The loans sanctioned amounted to £18,942, and the full amount was borrowed at 3½ per cent. The half circuits are extinguished at midnight during the winter months, and are relighted again from 5.30 a.m. till daylight. The financial year of the Corporation ends October 31, and the accounts are for running from May 29 to October 31, 1894, and from November 1 to October 31, 1894-5 :

	1894.		1894-5.
Capital expended	£16 653	.....	£18,942
Capacity of plant (kilowatts)	180	.....	180
Street-lighting only—number of 500-watt 2,000 nominal candle-power arc lamps erected	170	.....	170
Hours of lighting	1,104	.....	2,838
Estimated units generated	93,872	.....	241.302
,, ,, used per lamp	552	.....	1,419
Works costs per lamp	—	.....	£12 8 0
Total cost per lamp	—	.....	20 12 9

Costs of Production, Distribution, etc.

	1894. £	s.	d.	A. d.	1894-5. £	s.	d.	A. d.
Coal, etc.	265	5	6	·67	499	15	6	·44
Oils, waste, stores, etc.	78	17	6	20	96	13	8	·09
Carbons	153	2	0	·39	317	5	3	·31
Wages	305	9	0	·78	660	15	4	·65
Repairs and maintenance	12	8	10	·03	191	13	0	·19
Works costs	815	2	11	2 08	1,766	2	9	1 75
Rent, rates, and taxes	63	11	0	·16	64	10	5	·06
Management, printing, insurance, sundries, etc.	174	2	8	·44	260	8	9	·25
Total costs	1,052	16	7	2 69	2,091	1	11	2 07
Repayment of loan, principal, and interest	1,231	6	2	3 14	1,415	2	5	1 42
(A —Cost per unit).	2,284	2	9	5·86	3,506	4	4	3·49

Companies' Audits.—Mr. Sydney F. Morse writes on this subject :

"The correspondence between the Institute of Chartered Accountants and the Board of Trade with reference to the audit of electric light companies' accounts opens up several very interesting questions. It is perhaps not generally known that there is no enactment in the Companies' Acts requiring an audit of a limited company's accounts, except in the case of a banking company registered after August 15, 1879, as a limited company. It is true that the specimen form of articles given in Table A of the Companies' Act of 1862 provides for an audit, and that it is most unusual for any company to dispense with provisions in its articles requiring an audit, but an audit is not made obligatory by Act of Parliament.

"By Section 9 of the Electric Lighting Act of 1882 it is provided as follows : '9. The undertakers shall on or before the 25th day of March in every year fill up an annual statement of accounts of the undertaking made up to the 31st day of December then next preceding, and such statement shall be in such form and shall contain such particulars and shall be published in such manner as may from time to time be subscribed in that behalf by the Board of Trade,' and the model form of provisional order provides as follows : '8. The annual statement of accounts of the undertaking before being published as provided by Section 9 of the Electric Lighting Act, 1882, shall, so long as the local authority are not the undertakers, be examined and audited by such competent and impartial person as the Board of Trade shall appoint ; and the remuneration of the auditor shall be such as the Board of Trade shall direct, and the same and all expenses incurred by him in or about the execution of his duties to such an amount as the Board of Trade shall approve shall be paid by the undertakers on demand, and shall be recoverable summarily as a civil debt. The undertakers shall give to the auditor, his clerks and assistants, access to such of the books and documents relating to the undertaking as shall be necessary for the purposes of the audit, and shall, when required, furnish to him and them all vouchers and information requisite for such purpose, and shall afford to him and them all facilities for the proper execution of his and their duty. The Board of Trade may make and vary regulations prescribing the times at and the mode in which such audit shall be made and conducted, or otherwise, for the purpose of giving effect to the provisions of this section. Any report made by the auditor, or such portion thereof as the Board of Trade shall direct, shall be appended to the annual statement of accounts, and shall form part thereof for the purposes of the said Section 9.'

"There is no clause similar to Section 9 of the Act of 1882 in the Gasworks Clauses Act, or in the Railway Clauses Act, and the Companies' Clauses Act of 1845 merely provides for the election of auditors by the company, except where by the special Act auditors shall be directed to be appointed otherwise, and these auditors are directed to examine the accounts, and either to make a special report on the accounts, or simply to confirm the same, such report or confirmation to be read with the report of the directors at the ordinary meeting.

"On the other hand, the Metropolis Water Act of 1871 provides that every company for the time being supplying water for domestic use within the limits of the Act is to forward to the Board of Trade and certain other authorities a statement of account in such form and giving such particulars as may from time to time be prescribed by the Board of Trade, and there is to be an auditor from time to time appointed by the Board of Trade.

"Section 40 of this Act provides as follows: '40. The auditor shall once in every half-year audit the accounts of the companies. If he finds the accounts correct he shall certify the same, but if in any instance he finds the accounts of any company incorrect in principle or in detail, he shall require such company to correct such accounts in such manner as he thinks right, and no future dividend shall in any case be declared by any company until their accounts are certified by the auditor, provided that the suspension of a dividend under this section shall not operate until after the expiration of nine months from the date of the audit.'

"But any company thinking themselves aggrieved by any act or determination of the auditor can, under Section 42, bring the matter to arbitration.

"Now, it will be noticed that there is a great deal of difference between the provision for the annual statement of accounts to be made to the Board of Trade under the Electric Lighting Act, even when coupled with the audit clauses of the provisional order, and the provisions of the Metropolis Water Act of 1871, under which power is given to the auditor to require a company to correct any accounts which he finds incorrect in principle or in detail. And I submit that the auditing of an electric lighting company's accounts by the Board of Trade is merely made for the purpose of obtaining independently statements as to the expenditure, and as to the application of revenue with a view to the special provisions of the Act and provisional order, and particularly with a view to the anticipated purchase by the local authority at the expiration of the statutory period, and that the Board of Trade auditor has no power to direct such a company to alter its accounts in principle or in detail unless he can show that the company has committed a breach of the terms of the Electric Lighting Acts or provisional order.

"The letter from the Board of Trade recently published states (as I claim in support of this suggestion) 'that the Board of Trade audit is of a different character to that of a shareholders' audit, and has in view different objects.' Moreover, there is no audit clause in the model provisional order, the 'undertakers being a local authority.'

"Now, the object for which the shareholders' audit is made is that as between the directors and the shareholders it shall be shown that capital is not paid away in dividends, that all payments are duly vouched and all receipts duly entered, and proper provision made for bad debts or contingent liabilities, and, in fact, that the accounts are properly kept, having regard to the constitution of the company.

"If the above suggestions are correct, the importance will at once be seen of drawing the line between the two audits and limiting the rights of each auditor to interfere in the management of the accounts to the special provisions under which his appointment is made.

"If this is not done, each auditor may by degrees get into the way of directing not only how the accounts shall be kept, but also what amounts are properly chargeable to capital and revenue respectively, and if they do not take the same view very serious difficulties may arise ; whereas if, as I submit, the duties of the Board of Trade auditor are limited to ascertaining and seeing that the provisions of the Acts and order are duly carried out, while the shareholders' audit deals with matters arising out of the special constitution of each company and the proper keeping of the accounts, there need be no difficulty.

"But I do submit that there is this distinction, and that it should be carefully observed."

The following is a complete list of applications for provisional orders deposited with the Board of Trade up to December 21, 1895, under the provisions of the Electric Lighting Acts, 1882 to 1890 :

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Title of Order and Description of Area.	Name of Promoters.
Allerton, Woolton, Childwall, and Garston Electric Lighting Order. The Urban Districts of Allerton, Little Woolton, Much Woolton, Childwall, and Garston.	Liverpool District Lighting Company, Limited.
Ambleside Electric Lighting Order. The Urban District of Ambleside.	Windermere and District Electricity Supply Company, Limited.
Ashton-on-Mersey Electric Lighting Order. The Urban District of Ashton-on-Mersey, and a portion of the District of the Bucklow Rural District Council.	Altrincham Electric Supply, Limited.
Bath Electric Lighting Order. The City of Bath.	The Corporation.
Bath Electric Lighting Order. The City of Bath.	City of Bath Electric Lighting and Engineering Company, Limited.
Bray Township Electric Lighting Order. The Township of Bray.	The Township Commissioners.
Bristol Suburban Electric Lighting Order. The Urban Districts of St. George and Kingswood, and a portion of the Urban District of Stapleton and of the Rural District of Warmley.	Great Western Electric Light and Power Company, Limited.
Colwyn Bay and Colwyn Electric Lighting Order. The Urban District of Colwyn Bay and Colwyn.	The Urban District Council.
Cork Electric Lighting Order. The City or Borough of Cork.	The Corporation.
Cowes Electric Lighting Order. The Urban District of Cowes.	The Urban District Council.
Devonport Corporation Electric Lighting Order. The County Borough of Devonport.	The Corporation.
Folkestone Electric Lighting Order. The Urban District of Folkestone.	The Corporation.
Gloucester Corporation Electric Supply Order. The City of Gloucester.	The Corporation.
Godalming Electric Lighting Order. The Municipal Borough of Godalming.	The Corporation.
Great Berkhamsted and Northchurch Electric Lighting Order. Portions of the parishes of Great Berkhamsted and Northchurch.	Bedford Electric Light Company, Limited.
Great Crosby and Waterloo Electric Lighting Order. The Urban Districts of Great Crosby and Waterloo-with Seaforth.	Liverpool District Lighting Company, Limited.
Huddersfield Electric Lighting Order. The County and Municipal Borough of Huddersfield.	The Corporation.
Ipswich Electric Lighting Order. The Borough of Ipswich.	County of London and Brush Provincial Electric Lighting Company, Limited.
Keswick Electric Lighting Order. The Urban District of Keswick.	The Urban District Council.
Keswick Electric Lighting Order. The Township of Keswick and portions of the Townships of St. John's, Castlerigg, and Wythburn, Underskiddaw, and Above Derwent.	Keswick Electric Light Company, Limited.
Kettering Electric Lighting Order. The Urban District of Kettering.	The Urban District Council.
King's Lynn Electric Lighting Order. The Borough of King's Lynn.	The Corporation.
Kingstown Township Electric Lighting Order. The Township of Kingstown.	The Township Commissioners.
Liverpool Electric Lighting Order. The City of Liverpool.	The Corporation.
THE COUNTY OF LONDON.	
County of London (South) Electric Lighting Order. The District of the St. Saviour's District Board of Works, and the Parishes of St. Mary, Newington; St. Mary, Lambeth; St. Giles, Camborwell; and St. Mary, Battersea.	County of London and Brush Provincial Electric Lighting Company, Limited.
Battersea Electric Lighting Order. The Parish of St. Mary, Battersea.	The Vestry.
Newington Electric Lighting Order. The Parish of St. Mary, Newington.	The Vestry.
Manchester Electric Lighting Order. A portion of the City of Manchestr.	The Corporation.
Margate Corporation Electric Lighting Order. The Borough of Margate	The Corporation.
Merthyr Tydfil Electric Lighting Order. A portion of the Urban District of Merthyr Tydfil.	J. C. Howell, Limited.
Middleton Electric Lighting Order. The Borough of Middleton.	The Corporation.
Newmarket Electric Lighting Order. The Urban District of Newmarket and a portion of the Rural District of Newmarket.	Newmarket Electric Light Company, Limited.
Pembroke Township Electric Lighting Order. The Township of Pembroke.	The Township Commissioners.
Prescot District Electric Lighting Order. The Urban District of Huyton-with-Roby, and the Parishes of Rainhill, Whiston, and Eccleston.	British Insulated Wire Company, Limited.
Queenstown Township Electric Lighting Order. The Township of Queenstown.	The Town Commissioners.
Rathmines and Rathgar Township Electric Lighting Order. The Township of Rathmines and Rathgar.	The Improvement Commissioners.
Sale Urban District Council Electric Lighting Order. The Urban District of Sale.	The Urban District Council.
Wells (City of) Corporation Electric Lighting Order. The City of Wells.	The Corporation.

THE ARC LIGHT.*

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S.

LECTURE II.

(Continued from page 737, Vol. XVI.)

DEPENDENCE OF DISTRIBUTION ON SHAPE OF CRATER AND PEAK.

During the minutes which have elapsed our arc has been steadily burning and the crater on the upper carbon has assumed the oblique position. The peak remains as a peak and is visible against the crater surface, which it partially hides from our view. The main amount of light (see Fig. 10) is now given off in a not quite horizontal direction.

To make experiments on the amount of light given out in different directions one requires either a photometer capable of being shifted round into all possible angular positions or some apparatus for turning the arc into different inclinations with respect to the photometer. There is, however, an intermediate possibility—namely, some method of optically tilting the lamp so that its light shall still come to the photometer, no matter what the inclination may be. To enable you to see upon the screen what the arc looks like when viewed at different inclinations, the following apparatus has been devised (Fig. 13).

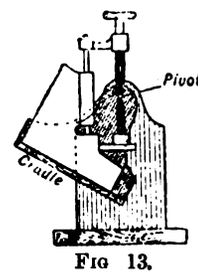

FIG 13.

Here is a small projector lamp (made by the Planet Company) for the purpose of magic-lantern work. This little lamp is fixed on a cradle-shaped stand so that it can be rocked about on horizontal trunnions, the line of axis of these trunnions passing right through the arc. When the arc is burning steadily, while we project its image upon the screen by means of a lens placed in front, we can tilt it to any angle desired and set it either vertically or with any desired inclination towards the horizontal plane. So here we accomplish the same result as viewing the arc obliquely from positions below.

* Cantor lectures delivered before the Society of Arts.

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If I set the cradle so as to bring the rim of the crater into the horizontal plane with the carbons vertical I shall have the arc in the position of habitual use (Fig. 1), and on the screen you see the sideway view. You see that very obvious peak and above it the edge of the white-hot crater. If I lengthen the arc a little you will see the peak burn away to a blunter form, while the crater will become flatter. Having now seen the form sideways, I will tilt back the cradle so that we may get another view of it. The duller spot which you see in the middle of the crater arises from the circumstance that we are employing a cored carbon—that is to say, a carbon with a hole down the middle—packed with carbon of a more or less soft quality and possibly not quite pure. As the cradle is tilted, the negative peak comes in front of the crater and shows dark against its luminous surface. Turning it to a still steeper angle so as to get in a horizontal direction the equivalent of the light which would otherwise be thrown obliquely downwards, we find the negative peak almost eclipsing the crater and cutting off its light.

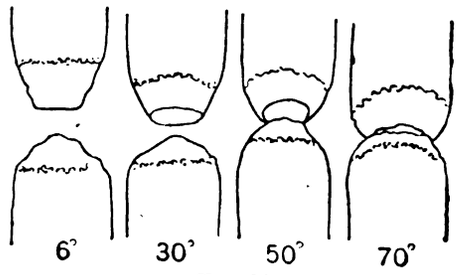

FIG. 14.

Fig. 14 shows four views at four different angles 0deg., 30deg., 50deg., and 70deg. In the two extreme positions, where the crater is seen only edgeways, and where it is eclipsed by the peak, there is very little light; but at some angle between these two there will obviously be a position where the light is a maximum. The crater, at first seen edgeways, seems to open out into an ellipse, which widens until the intruding peak eclipses it. There will obviously be a maximum position between the two minima. For a long time this was not very well explained. M. Rousseau, who made some observations by means of a polar photometer on the arc lamps shown at the exhibition at Antwerp in 1885, tried to express the results by using some long and complicated formulæ.

TROTTER'S THEORY OF DISTRIBUTION.

In the spring of 1892, Mr. Alexander P. Trotter, who has done so much in arc lamp optics and physics, showed a much simpler way of treating the matter. He started from the physical standpoint at which I explained in my first lecture I arrived in 1889—viz., that because the arc is a phenomenon due to the volatilisation of carbon, it will have a definite temperature, and, therefore, assuming that temperature to be definite and the carbon to be pure, the light emitted at the crater surface will have a definite whiteness. Starting from that point he argued as follows: It does not matter for optical purposes whether the crater is actually flat, or whether it is literally of a cup shape, since a luminous surface gives out only as much light in any direction as would be given out by a flat surface of equal intrinsic luminosity having exactly the same outline. This may seem a little strange, because it is contrary to one's experience of surfaces that are not self-illuminating. Take, for instance, an ordinary white saucer illuminated by the sky or by artificial light. If you set that saucer up in any one particular position, and enquire how much light it throws to your eye as you move round it in different directions, you will find as matter of measurement that the amount of light given out in different directions does not depend simply on the visible size of that saucer, but owing to the circumstance that it receives its light at a particular angle and reflects it; the amount of light given out to your eye by any visible area of its surface depends upon the angle at which you see it. But where you are dealing with a self-luminous surface this is no longer true. For instance, take a piece of white paper as a sort of model; imagine it to be a white-hot surface. Look at it through any definite aperture—for instance, through this tube. You will see a round luminous disc (of a certain size, limited by the aperture). It will not make 1 per cent difference whether the white surface behind it is absolutely square across or whether it is turned or tilted obliquely. As long as there is enough white surface behind to extend completely across the visible aperture, the aperture will look equally bright. The angle of incidence to the sloping surface behind the aperture has nothing to do with the brightness. The self-luminous surface is equally bright whether it slopes or whether it stands squarely opposite to the eye. The crater surface may, therefore, for optical purposes, be considered to act as a small white-hot horizontal disc.

The amount of light that it will emit in any given direction will depend simply, in the first place, on the intrinsic brightness, and, secondly, on the visible area which it presents when viewed in that direction. The more obliquely it is viewed the less is the visible area. The amount of light ought to be strictly proportional to the apparent area as viewed in the direction in question. Mr. Trotter's first point, then, is that the crater, no matter what the actual hollow may be, may be treated as a flat disc suspended somehow or other up in the air, and shining white hot. Then what will be the geometrical distribution of light in all directions from this disc? That will be simply a matter of angle, or, rather, of the cosine of the angle. The disc will appear biggest, at any given distance away, if the eye is placed exactly opposite it. Because when the disc is square across the line of sight, it obviously will subtend the greatest apparent angle in space. It will appear of no size at all in directions at right angles to this, because the disc is edgeways, and the edge has no visible magnitude quantity. There will be no light in that direction; in other directions there will be some light. There will be a maximum in the direction of the normal to the surface; and the amount in any other direction will be simply proportional to the cosine of the angle which that direction makes with the normal. If you take the cosine of the angle as measured from the normal, or the sine of the angle as measured from the horizontal plane, and plot out the values in a polar diagram, as in Fig. 16 below, you will find the points all lie on a semicircle. In brief, cosines plotted as a polar curve give geometrically a circle that passes through the pole. Therefore, if this law were to be literally fulfilled, and if our crater were a horizontal disc up in the air—whether circular in outline or not is immaterial the amount of light measured in different directions, provided there were nothing to interfere, would plot out simply on a semicircle, giving us the diameter of the semicircle as the greatest amount of light measured down underneath the disc. Unfortunately, the arc lamp consists of something more than a top carbon with a level crater at the end of it. There is that unavoidable negative peak which gives out very little light of its own, which is merely being roasted in the heat of the crater above it, and which casts a shadow. If you will measure the amount of the eclipse that goes on in different directions, you will get a measure of the amount of light cut off in those directions from the amount that would be strictly proportional to the cosine of the angle. No sooner had Mr. Trotter conceived this idea than he was good enough to come and talk it over with me at the Technical College. I put one of my senior students, Mr. C. F. Higgins, at his disposal to devise a little piece of apparatus to test this theory. Mr. Higgins constructed the apparatus used by Mr. Trotter in the investigations which followed. I have the apparatus here (Fig. 15)

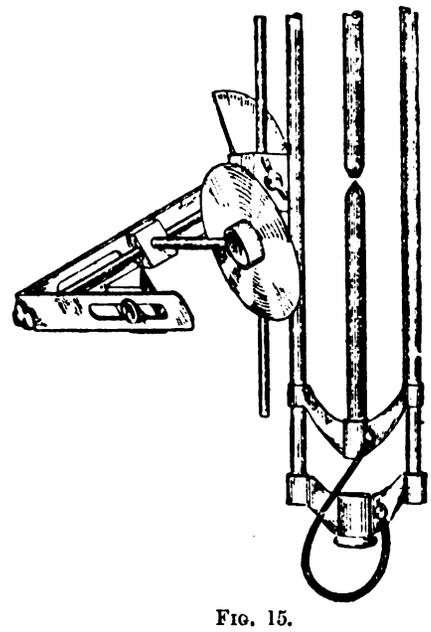

FIG. 15.

fixed on one of the Planet Company's lamps. There is attached to the framework of the lamp the small apparatus by means of which the light given out from the arc in any direction can be examined. A lens is placed opposite the arc at a certain distance away; the light from that lens is received on a small mirror, having its front face metallised. The mirror being set at 45deg., sends out the light at right angles, to a distant screen, where the image is received. Then by merely tilting to any desired angle the frame which carries lens and mirror, one can examine, in any direction within wide limits, the visible appearance as presented in that direction. Armed with this instrument, one can make photometric measurements of the light sent out at different angles without moving either lamp or photometer. But of more importance is the fact that by focussing the images on the screen one can make pictures of the visible forms of the carbons. Putting a sheet of white paper against the screen you project on it any particular view of the

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arc you like, and then with a drawing-pencil outline the projection on the paper. Having in this way obtained a series of sketches of the arc as projected at various known angles (and all on the same scale), you may then go over each sketch with a planimeter and measure up the amount of luminous surface that is visible in different directions.

This elegant method of determining the illuminating effect at different angles is a feature of Mr. Trotter's investigation. In his paper in the *Journal* of the Institution of Electrical Engineers Mr. Trotter gives his results plotted out in the form of curves. In one curve he plotted the intensity of the light as measured in different directions. In another curve he plotted the amount of visible crater area as measured in the different directions. So close is the agreement that the curves are scarcely to be discriminated one from the other. Fig. 16 gives

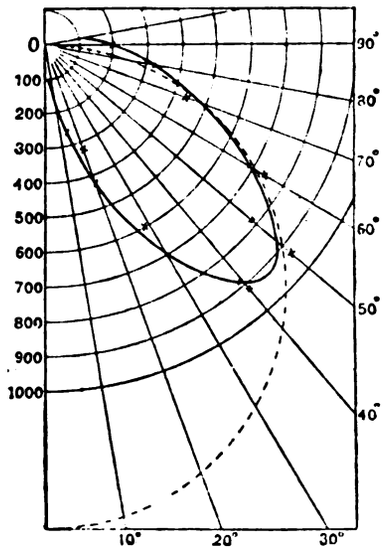

FIG. 16.

the curve of visible areas plotted as a polar diagram. The dotted semicircle gives the values of the cosines, which are proportional to the area of crater surface which would be visible if it behaved exactly as a disc, and had no obstruction in front. The light in any given direction is apparently proportioned to the amount of visible crater area exposed in that direction. This is a very important result, because it enables us to see exactly why the light is distributed as it is. Before Mr. Trotter's experiments there had, however, been some other observations made, dealing with the relation between the amount of light and the amount of current.

INTRINSIC LUMINOSITY OF THE CRATER.

Let us proceed to correlate Mr. Trotter's observations on the relation between the amount of light and the crater surface with those earlier observations on the relation between the crater surface and the current.

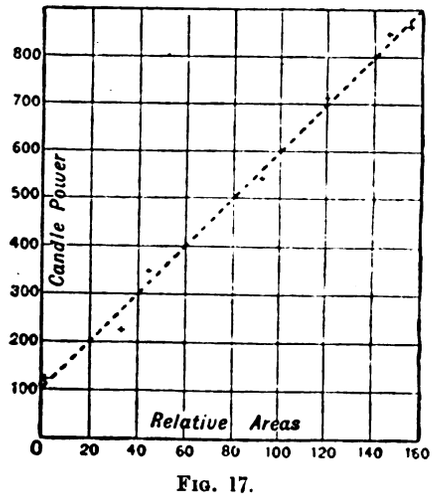

FIG. 17.

We will take, first of all, Mr. Trotter's results, in which we compare together the amount of light, as measured photometrically, and the amount of crater area, as determined by projecting the images on the screen, and measuring them with a planimeter. Fig. 17 gives in graphic form the result of Mr. Trotter's researches on the relation between the candle-power of the arc and the visible area of the crater surface. The candle-power is plotted out vertically, and the corresponding areas of crater surface are plotted out horizontally; they lie practically on a straight line. The main thing substantiated is that, taking a certain datum line horizontally across the diagram at about 100 candles, any amount of light above that datum line is exactly proportional to the amount of area of crater surface. Then what is the meaning of having this datum line above the actual zero of candle-power? It means this, that all the light below that line drawn at about 100 candles was due to other parts than the crater. That is to say, the total amount of light given out by the negative peak by the duller red-hot regions around the peak, and around the rim of the crater and by the flame of the arc, amounted to about 100 candles. If we then discount this extra light which strays in from the other parts, we may say that the light given out is strictly proportional to the area of the crater surface. The other result I wished to correlate with this was an observation of Mr. J. D. F. Andrews's on the relation between the crater area and the current going through the lamp. This research dates from 1880, before we began to talk about amperes of current, and when we talked about webers. Andrews's researches were on the number of webers of current going through a searchlight, and the amount of crater area as measured in the following way: After the lamp has been allowed to burn steadily for a given time, the current was stopped, and the carbons taken out. The size of the crater was measured up, and from that the area of crater surface was calculated. The observations plotted together, as in Fig. 18, give a straight line which goes right down to zero. The current in these experiments was found to be rigidly proportional to the actual area of the crater. Consequently it follows, from Mr. Trotter's results, that the amount of light given out by a lamp (in any given direction) is also proportional to the current passing through that lamp.

If, then, the light emitted is simply proportional to the effective crater area, it ought to be possible to set down in definite terms the specific luminosity of the arc crater as so many units of light per unit of area. Many years ago, Mr. Hiram Maxim had arrived, I know not by what process, at a similar conclusion. He gave the rough-and-ready rule that you can calculate the total candle-power of a lamp by measuring the diameter of the crater in hundredths of an inch, squaring the number, and then multiplying by 10. This is equivalent to 127,000 candles per square inch, or approximately 200 candles per square millimetre—a figure which is high compared with those of other observers. Abney's values range from 39 to 116; Andrews's

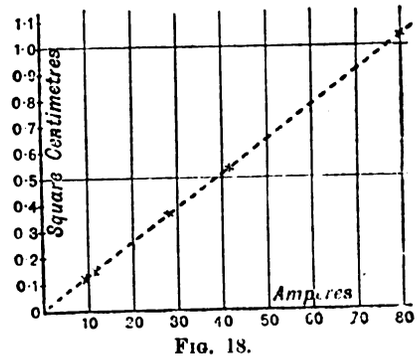

FIG. 18.

from 64 to 170; Trotter's, from 80 to 170; while Blondel's value is 160. The number of amperes per square millimetre of crater surface is about 0·78; so that the number of candles per ampere should be over 200. Palaz gives 204 to 240 in the direction of maximum brightness.

It will not, however, do to jump to the conclusion that because the crater area, and, therefore, the total quantity of light emitted, is proportional to current, that doubling the current in any given arc lamp will exactly double the light that that lamp gives out. For, if the current used at first is appropriate for the carbons of the size employed, a double current will be much too great to produce a proper crater, and the pencils will overheat. Moreover, the distance between the tips and the form of the tips will differ, and the distribution of the light will be different, preventing a fair comparison. Palaz gives the empirical rule that for a given lamp and carbons working between 40 and 50 volts, the number of candles (*bougies decimales*), if measured in the direction of maximum brightness, is equal to $200\,C + 4\,C^2$, where C is the current expressed in amperes. According to this, a 10-ampere current would give 2,400 candles in the maximum direction, while one ampere would only give 204. (The mean hemispherical brightness is only about two-thirds of the maximum.)

[*Note added, October*, 1895.—Shortly after the delivery of this lecture, Mrs. Ayrton published in the *Electrician* the results of her measurements of the crater, from which it appears that the current is not exactly proportional to the area of the crater, nor yet to its diameter, but to some power of the diameter between 1 and 2. On examining the curves on which her formula is based, it seems evident that further experiments are needed before the approximate law that the area of the crater is proportional to the current can be condemned.—S. P. T.]

(To be continued.)

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EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.

Report of the Committee, consisting of Prof. CAREY FOSTER (chairman), LORD KELVIN, Profs. AYRTON, J. PERRY, W. G. ADAMS, and LORD RAYLEIGH, Drs. O. J. LODGE, JOHN HOPKINSON, and A. MUIRHEAD, Messrs. W. H. PREECE and HERBERT TAYLOR, Prof. J. D. EVERETT, Prof. A. SCHUSTER, Dr. J. A. FLEMING, Profs. G. F. FITZGERALD, G. CHRYSTAL, and J. J. THOMSON, Messrs. R. T. GLAZEBROOK (secretary) and W. N. SHAW, Rev. T. C. FITZPATRICK, Dr. J. T. BOTTOMLEY, Prof. J. VIRIAMU JONES, Dr. G. JOHNSTONE STONEY, Prof. S. P. THOMPSON, Mr. G. FORBES, and Mr. RENNIE.

The work of testing resistance coils at the Cavendish Laboratory has been continued. A table of the coils tested is given

TABLE—OHMS.

Number of coil.	Value of coil.	Temperature (deg.).
Nalder 4,341 C.L.C. 422	·99849	11·8
Nalder 4,650 C.L.C. 423	1,000 (1 − ·00041)	15
Elliott 309 C.L.C. 424	·99902	13·1
Elliott 310 C.L.C. 425	·99915	13·2
Elliott 311 C.L.C. 426	·99956	13
Elliott 312 C.L.C. 427	·99911	13·2
Elliott 313 C.L.C. 428	·99903	13
Elliott 314 C.L.C. 429	·99912	13·1
Elliott 315 C.L.C. 430	9 9901	11·7
Elliott 316 C.L.C. 431	9 9873	11·6
Elliott 317 C.L.C. 432	9 9914	12
Elliott 318 C.L.C. 433	100 (1 − ·00014)	14·1
Elliott 319 C.L.C. 434	100 (1 − ·00027)	14
Elliott 320 C.L.C. 435	100 (1 − ·00023)	13·9
Nalder 4,651 C.L.C. 436	·99899	13·8
Nalder 4,653 C.L.C. 437	9 9846	12
Nalder 4,654 C.L.C. 438	9 9833	12·1
Nalder 4,655 C.L.C. 439	100 (1 − ·00068)	14·3
King-Mendham C.L.C. 440 ...	1·00078	15·2
Nalder 4,934 C.L.C. 441	·99926	14·1
Paul 36 C.L.C. 442	9 9969	13·7
Wigston 449 C.L.C. 443	9 9988	14·3
Wigston 440 C.L.C. 444	·99888	17·3
Wigston 450 C.L.C. 445	100 (1 − ·00030)	17·3
Wigston 453 C.L.C. 446	1,000 (1 − ·00067)	17·3
Nalder 4,561* C.L.C. 409	1,000 (1 + ·00039)	15·2

* Retested (see report for 1894).

The resistance coils referred to in the last report as defective in insulation have been refilled, and up to the present their insulation has proved satisfactory.

The set of standards ordered from Germany has not yet arrived. When they are received a careful comparison will be made between their values and those of the standards of the association.

During the year the committee have had under discussion a paper on magnetic units prepared by Dr. Lodge and printed as an appendix to this report.

The committee recommend that they be reappointed; that Prof. G. Carey Foster be chairman, and Mr. R. T. Glazebrook secretary.

APPENDIX.

MAGNETIC UNITS.

To the British Association Committee on Electrical Standards:

Believing that the committee is impressed with the convenience of affixing names to some of the more important units connected with the magnetic circuit I beg to suggest the following considerations and recommendations, which I will write out as briefly as possible. The statements are intended to be precise in their terms, but in several cases alternative forms of definition are given

(1) That the unit coefficient of self induction, though frequently useful, is by no means one of the most fundamental units, but should be defined in a suitably subordinate manner with reference to other and more important quantities.

(2) That it would be a mistake so to define it as to discourage the employment of the same term for as many other quantities of the same "dimensions" as possible; especially for the unit coefficient of mutual induction, and for unit "permeance."

(3) That the essentially different quantities commonly called H and B should be carefully kept distinct, although their measures in air have been conventionally so arranged as to be numerically equal.

(*Summary of Known Facts and Definitions*).—H being the intensity of magnetic force at a point, or the slope of magnetic potential, ω,

$$\omega_a - \omega_b = \int_a^b H\,ds, \text{ along any portion, } a\,b, \text{ of a line of force;}$$

and in a closed magnetic circuit the circuitation of H is equal to 4π times the total electric current through the area bounded by the magnetic circuit; or,

$$\text{cycle } \int H\,ds = \text{circuitation of } H = \iint 4\pi c\,dS = 4\pi C.$$

or, at any point of space, $\text{curl } H = V\nabla H = 4\pi c$; where c is current density.

If the electric circuit consists of n turns of wire threading the magnetic circuit, and each conveying the current C_1, then $C = n C_1$

First Quantity to be Named.

(4) The first thing requiring a name is this quantity *magnetic potential*, sometimes called *magneto-motive force*; a quantity spoken of and measured, not inconveniently but with insufficient generality, by electrical engineers as ampere-turns. It has been proposed (by Mr. Heaviside for instance) that it be called *gaussage*, and that its C.G.S. unit be one *gauss*.

(5) The circuital gaussage round a closed curve is 4π times the total electric current through the area bounded by that curve. In the case of a magnetic circuit wound with wire the gaussage is $1\frac{1}{4}$ times ($\frac{4\pi}{10}$ or 1·2566) the ampere-turns threading that circuit.

Note.—It *may* be best to retain the word "gaussage" for the whole of a closed circuit only, and to speak of the difference of magnetic potential between two points as the fall of gausses or the "gauss-fall" from a to b.

(6) The gaussage, or gauss-fall, in any portion $a\,b$, of a magnetic circuit is measured by the change in the potential energy of a unit pole as it moves from a to b by any path which involves neither the cutting of magnetic layers nor the encircling of currents (a long channel being imagined for its motion through solid material if necessary). Or, more practically, it is measured by the induction through a long narrow tube whose ends are at a and b respectively, divided by the permeance of that tube. (*Cf.* Chattock on a magnetic potentiometer, *Phil. Mag.* July, 1887.) In practice, however, gaussage is frequently calculable from the ampere-turns to which it is due.

(7) Intensity of magnetic force, or H will be naturally expressed as gauss-fall per centimetre, or the *gauss-gradient*. For instance, the earth's horizontal intensity at some place is ·18 gauss per linear centimetre, or 5·4 gausses per foot.

Note.—It should not, strictly speaking, be expressed as so many lines per square centimetre; that mode of expression should be reserved for induction density, B. H is the cause, and should be thought of as the slope of magnetic potential, B is the effect. In a medium of so-called unit permeability the two quantities are numerically equal, but they should not be confounded, any more than the slope of electric potential, or electric intensity (e) should be thought of as identical with current density, even in a medium of unit conductivity.

(8) The gauss gradient inside a long or closed magnetic solenoid of length l, wound uniformly with n turns of wire each conveying the current C_1, is $4\pi n C_1/l = 4\pi n_1 C_1$; where n_1 is the total number of turns of wire (in all the layers) to the linear centimetre. This is the measure of H in the interior of such a solenoid, quite irrespective of the material with which it may happen to be filled.

Second Quantity to be Named.

(9) The second quantity requiring a name is the *total induction* in a magnetic circuit, also called "total flux," "total lines," "electromagnetic," and "electrotonic state." It is the quantity whose time-rate of variation gives the voltage induced in an electric circuit surrounding it once. It is proposed that its practical unit be called a "weber," and be defined as equal to 10^8 C.G.S. lines (or unit tubes) of induction. (Denote the quantity for the present by N, and its density by B.)

Summary of Known Facts.—e being the intensity electric force, or the slope of electric potential, or the volt-gradient a point; the circuitation of e = the induced E.M.F. in a closed circuit = the rate of change of induction through it;

$$\text{or, } \text{cycle } \int e\,ds = E = -\dot{N} = -\iint \dot{B}\,dS;$$

or, at any point of space,

$$\dot{B} = -\text{curl } e = -V\nabla e.$$

Through a simple closed electric circuit of constant resistance,

$$N = -\int E\,dt = \int R C\,dt = R Q.$$

(10) The total induction through any area may be practically measured by suddenly surrounding it with a closed-wire circuit of n turns connecting the terminals of a ballistic galvanometer, and measuring the quantity of electricity thereby impelled through the galvanometer. The induction is equal to the quantity so impelled divided by n times the resistance of the circuit. If the quantity is one coulomb, and the resistance one ohm, the induction is $1/n$th of a weber. Or, otherwise, if the induction through any boundary changes at the rate of one weber per second, the E.M.F. excited in that boundary is one volt. In the case of a wire circuit through which induction is varying at the rate of a weber per second, one volt is excited *in each turn* of the wire.

(11) *Another* mode of measuring the total induction through an area is to surround that area with a movable electric circuit of n turns of wire conveying a known current, and to measure the potential (or mechanical) energy of the circuit under those conditions. The induction is equal to the potential energy of the circuit divided by n times the current circulating in each turn of wire. Or, if the induction through a simple circuit carrying one ampere is one weber, the potential energy of the circuit is one joule.

Derived Quantities.

(12) Induction density, or B, may be expressed as so many webers per unit area; say, per square centimetre or per square inch, or whatever is preferred for practical purposes. For instance, the earth's horizontal induction density at some place is ·18 C.G.S.

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unit = $\cdot 18 \times 10^8$ weber per square centimetre = 18 microwebers per square metre.

(13) The inductivity, μ or absolute permeability of a medium at any point under specified circumstances, is the ratio of B to H at that point, and under those circumstances. In many substances this ratio is far from constant. [It may be expressed in terms of henries or other units of permeance per unit length (see below), instead of C.G.S. units, if convenient. For example the inductivity of air is $\frac{1}{1000}$th of a microhenry per centimetre, or one millihenry per kilometre.] More explicitly it is measured by the webers per unit area divided by the gauss fall per unit length; in other words, by the ratio of the weber density to the gauss gradient.

(14) The relative inductivity of a substance is compared with that of empty space (μ/μ_0) may be called simply its "permeability" as at present and is a mere number. (Its electrical analogue is specific inductive caacpity (K/K_0), as contrasted with absolute electric inductivity (K); which latter could be defined in practical units as the ratio of the coulombs displaced per unit area to the volt gradient.)

Third Quantity to be Named.

The third quantity for whose unit a name is required is some form of ratio between the two fundamental quantities whose units are here named after Weber and Gauss respectively. It has been practically decided in America that this unit shall be named after Prof. Henry, of Washington, but the precise definition has not yet been agreed upon.

There are two quantities of the same physical dimensions to which the name is applicable—viz., the coefficient of self or mutual induction of a coil or coils of wire, and the permeance or inverse reluctance of a magnetic circuit.

The most logical order is to define permeance first as the ratio of the webers of induction to the exciting gaussage, and then to say that the inductance of a coil of n turns of wire is n^2 or $4\pi n^2$ or $\cdot 4\pi n^2$ times the permeance of the magnetic circuit which it embraces, according to the units of gaussage and current which have been decided on. If the units of gaussage and current are both the C.G.S. units, then $4\pi n^2$ is the numerical factor connecting inductance with permeance. If the C.G.S. unit of gaussage is adopted along with the ampere current, then $\cdot 4\pi n^2$ is the factor. But if the circulation of H due to *one ampere turn* is adopted as the practical unit of gaussage, then n^2 is the factor, and the permeance of a cylinder, instead of being simply $\frac{\mu A}{l}$, is $\frac{4\pi\mu A}{10 l}$.

The apparent simplicity of this last system has much to recommend it for commercial use, though it will complicate the specification not only of permeance but also of magnetic fields and potentials; but *some* inconvenience due to the unfortunate definition of the unit pole, and the only less unfortunate definition of the practical unit of current, cannot be avoided; but our aim must be to place the inconvenience where least likely to be felt in everyday work.

First System.

We will begin with the more logical system, and with general statements which apply to both.

(15) In a complete magnetic circuit the ratio of the total induction to the corresponding gaussage under specified conditions is called the "permeance" of that circuit under those conditions. It is not, in general, constant. Or, the permeance of any solenoidal portion of a magnetic circuit, if free from intrinsic magneto-motive force or magnetic boundary layers, is the webers through it divided by the gausses between its ends.

(16) The practical unit of permeance is that of a circuit in which a weber is excited by a gauss. Its reciprocal is the unit of reluctance. The practical unit so defined is 10^8 C.G.S. units.

Examples.—The permeance of a cubic metre of air to parallel induction from one face to the opposite is one microweber per gauss. Under circumstances such that the permeability of iron is 400 times that of air, the permeance of an iron ring of one decimetre cross-section and one metre in mean diameter is $\frac{400\pi r^2}{2\pi R} = 20r = 100$ C.G.S. = again one microweber per gauss. It is, perhaps, a question whether this amount of permeance could be called a "microhenry" without confusion.

Explanation.—The inductance (or self-induction coefficient) of an electric circuit consisting of n turns of wire, so far as it is constant, is defined to be equal to n times the induction produced through it by a current of one ampere in each turn. But the gaussage due to n ampere-turns is $\frac{4\pi n}{10}$ or $\cdot 4\pi n$; hence the inductance of a wire coil is $\cdot 4\pi n^2$ times the webers caused by each gauss in the magnetic circuit surrounded by it—*i.e.*, $\cdot 4\pi n^2$ times the permeance of that circuit considered as constant.

(17) A coil of wire threading n times a complete magnetic circuit of unit permeance under any given circumstances is said to have $\cdot 4\pi n^2$ units of inductance under those circumstances, and, in general, the inductance of a coil of n turns is $\cdot 4\pi n^2$ times the permeance (as above defined) of the magnetic solenoid enclosed by it. (The permeance may here be considered variable.) [With the ampere-turn as unit gaussage the $\cdot 4\pi$ is prefixed similarly to both inductance and permeance, so that only the factor n^2 is needed to convert one into the other. See below.]

(18) The C.G.S. unit of inductance is equal to n times the induction excited through a coil per C.G.S. unit of current in every turn of wire, whereas the practical unit of inductance is n times the webers excited per ampere, hence the practical unit of inductance is 10^9 times the C.G.S. unit. The practical unit is called a "henry." (It has also been called secohm and quadrant.)

Example.—If the above iron ring were wound closely with 1,000 turns of wire, the coil would have a coefficient of self-induction equal to $\frac{4\pi}{10}$, or 1¼ henries whenever the permeability of the iron was 400. A coil of 20,000 turns of wire, wound closely on the same core, would have an inductance of 1¼ henries if it contained air or other non-magnetic substance.

Alternative Mode of Definition of Inductance on First System.

In view of one of the above practical methods of measuring induction experimentally, the inductance of coils of wire, both self and mutual, may be defined more directly thus:

(19) When of two simple circuits one conveys a current, the other, in general, has induction caused through it, and the ratio of the induction through either to the inducing current in the other is called the mutual inductance of the circuits.

(20) Of two coils with n and n' turns respectively, the total mutual inductance is to be reckoned for every turn of wire on each coil, and is therefore $n\,n'$ times the inductance of the mean turn of one coil on the mean turn of the other.

(21) The mutual inductance of two coils is $4\pi n\,n'$ times the permeance of the largest magnetic solenoid which threads both. For if every turn of one conveys a current C, while every turn of the other surrounds an induction, N', in consequence, the permeance of the magnetic solenoid threading the second coil is $P = N'/4\pi n\,C$; but the total effective mutual induction, M C, through all the turns is $n'\,N'$; hence $M = 4\pi n\,n'\,P$.

(22) When two coils each conveying one ampere are constantly connected by one henry of mutual inductance the kinetic energy of the field due to their mutual action is one joule.

(23) If the *self* induction coefficient of a coil is being considered, its total inductance may be taken as n^2 times the inductance of the mean turn—that is, n times the total induction through it divided by the inducing current; or the weber-turns per ampere give the self-inductance in henries.

(24) The practical unit of inductance, whether self or mutual, is called a henry; and a coil of n turns has a henry of inductance, on itself or on another of n' turns, when an ampere in one maintains $1/n'$ weber of induction (through itself or) through the other.

(25) When the induction through a coil varies for any reason at the rate of one weber per second, the E.M.F. generated in each turn is one volt.

(26) When the inductance of a coil is one henry, on itself or on another, a small variation of current in it at the rate of one ampere per second induces an E.M.F. of one volt in itself or in the other.

(27) When the inductance of a coil conveying one ampere varies at the rate of a henry per second, the induced E.M.F. is one volt.

(28) When the self-inductance of a coil is constantly, or on the average, one henry, while an ampere current is generated in it, the kinetic energy of the field due to that ampere is half a joule.

Second System.

(29) If instead of taking a gauss as equal to a C.G.S. unit of magnetic potential, we take the circulation of H caused by one ampere-turn as the practical unit of magneto-motive force, we shall have one ampere-turn $= \frac{10}{4\pi}$ C.G.S. units of gaussage.

(30) The practical unit of permeance will then be that in which a weber of total induction is excited by each ampere-turn; in other words, it will be $4\pi \times 10^7$ C.G.S. units of permeance.

(31) And the practical unit of inductance will be that of a coil in which an ampere in every turn excites $\frac{1}{n}$th of a weber through every turn—that is to say, the inductance of a coil will be n^2 times the permeance of the magnetic circuit surrounded by it.

(32) The difference between inductance and permeance is only one of reckoning. Permeance is webers per ampere-turn. Inductance is weber-turns per ampere.

SUMMARY OF THE ADVANTAGES OF THIS SORT OF MODE OF DEFINING UNIT INDUCTANCE.

The special feature of this mode of defining the "henry" is that it makes inductance depend on the simple ratio N/C, or weber-turns per ampere, instead of on something more complicated.

It might possibly be defined as the ratio $d\,N/d\,C$—that is, as proportional to the tangent of the slope of the B : H curve; and such a definition would emphasise its variability, but certain practical advantages would be lacking, because it would be detached from any connection with the *permeance* of the circuit. The N/C ratio, on the other hand, instantly connects itself with permeance, and represents the slope of the secant drawn from the origin to any point of the B : H curve. It exhibits the variability sufficiently, making the inductance reach a maximum at the shoulder of the curve, and then slowly decrease as saturation sets in.

It is sometimes said—but the mode of expression is, to say the least, very inconvenient—that there are three different principles on which to define L, all leading to a different result—viz., numbering them inversely, but giving them in their usual order:

(3) Energy ..... $W = \frac{1}{2} L C^2$;
(2) E.M.F. ..... $E = L\,d\,C/d\,t$;
(1) Total induction $N = L C$.

But the real facts to be expressed are not here exhibited. The real facts are—

(1) $N = L C$;
(2) $E = d\,N/d\,t$;
(3) $d\,W = C\,d\,N$.

The essential thing to name is therefore N; and if 10^8 C.G.S. lines or unit tubes be called a "weber," or a "weber-turn," then a volt is a weber or a weber-turn per second, and a joule is a

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weber-ampere turn. Nothing can be handier than that, and a henry can be defined as a weber-turn per ampere.

Instead of saying as above, that there are three ways of defining L, the simplest thing is to say that two of the three equations as first given above are incorrect, except for the special and in practice comparatively rare case when L is constant. Written out correctly they stand as follows :

$$(1)\ N = L\,C\ ;$$

$$(2)\ E = \frac{d\,C}{d\,t} + C\,\frac{d\,L}{d\,t}\ ;$$

$$(3)\ W = \tfrac{1}{2}\,L\,C^2 + \tfrac{1}{2}\int_0^C C^2\,d\,L.$$

It is then obvious that (2) and (3) are too complicated to base a definition upon, and that the first alone gives a feasible system

The fact that L is decidedly not, in general, constant deprives the henry of any such importance as the ohm possesses ; moreover, it refers explicitly to rather a special thing—viz., a coil of wire and that under specified conditions, if it contain iron ; hence it would be rather absurd to name this alone of all magnetic units In the above communication, in addition to a certain mode of defining the henry, it is urged that unit total induction be named too ; for this is the quantity which is of real engineering importance—this is the quantity to attain which field magnets are built, and in the midst of which armatures are spun.

It is also urged that it would be convenient if unit magnetic potential could likewise be named, since electrical engineers have shown that they have need of some such unit for the exciting cause of induction, by their practical employment of the phrase "ampere-turns." The introduction of a gauss unit, in some form not too obviously limited to the case of a wire-wound coil, would assist teaching and would clarify magnetic ideas.

The present writer does not presume to decide between the two alternative systems of defining "the gauss" as given above—viz., the C.G.S unit on the one hand, and the ampere-turn on the other.

OLIVER J. LODGE.

Liverpool, December 9, 1894.

APPENDIX.

It need hardly be said that in the last resort it rests with practical men to employ or decline any suggested system of units. Those who daily deal with the quantities under consideration are the best judges of the utility or otherwise of a suggested unit, provided always that they take the trouble to give it a fair trial and see how it works in practice. It may be hoped that the above or similar suggestions will meet with criticism at the hands of such men, and in order to make a beginning of criticism I asked the Departmental Lecturer on Electrotechnics at University College, Liverpool (Mr. F G. Baily), to consider them with special reference to (1) the large size of the weber and henry units ; (2) the handiest definition of the gauss ; and (3) the least troublesome mode of bring in the 4π.

His reply, which is annexed, covers these points, and also incidentally refers to the quantity called I, or intensity of magnetisation.

Now, as must often have been pointed out, the equation $B = H + 4\pi I$ is a barbarous one, involving as it does quantities of different dimensions in one equation. Its true meaning is of course $B = \mu_0 H + (\mu - \mu_0) H$; which, although algebraically only a roundabout method of writing $B = \mu H$, is yet convenient, as exhibiting separately the part of the induction due to the ether and the part due to a material medium.

The customary convention of further denoting $(\mu - \mu_0)/\mu_0$ by the symbol $4\pi\kappa$, and then christening κH as the magnetisation, I, is likewise convenient. With this definition κ is a pure number, and I is a gau-s-gradient or field intensity. Another, but on the whole less satisfactory, definition—viz , the omission of μ_0 from the denominator—would make κ of the same dimension as μ, and I an induction density.

The pull between two parallel magnetised surfaces of area A is $\frac{1}{2} A B H \div 4\pi$—that is to say, $N H/8\pi$, and is therefore measured in webers multiplied by the gauss gradient, or in joules per centimetre. But to maintain an induction density B in air requires a gauss-gradient B/μ_0, hence we might write the pull across an air-gap $N^2 \div 8\pi\mu_0 A$. If the induction density across an air-gap is expressed in microwebers per square centimetre, the tension there comes out in units, of which 2,500 would make an atmosphere, or, roughly, in pounds per square foot.

As for the strength of a magnetic pole—a quantity which, though fundamental in one sense, is seldom really dealt with - it will naturally be expressed in ergs per gauss, or in joules per gauss if it is very strong.

Mr. Baily's chief practical suggestions are first that a special unit of permeance, other than the henry, is desirable, and next that the $4\pi/10$ had best be thrown on to the μ so as to keep the gauss equal to one ampere-turn. The fact that the inductivity of air will then cease to appear in its artificial garb of unity may even be regarded as a positive advantage, because its existence will then be less likely to be ignored. But I much fear that the ampere-turn as unit of gaussage, so near the C.G.S. unit in size and yet not equal to it, will be awkward and may lead to mistakes.

O. J. L.

University College, Liverpool, January 15, 1895.

Dear Prof. Lodge,—In reference to the sizes of the magnetic units proposed by you, I find that the weber 10^8 C.G.S. would only be used in fractions. The largest dynamo that I know of has a magnetic flux, or, as you propose to call it, an induction of ·5 weber. From this the value will go down to about ·01 in small motors. These figures are, however, by no means inconvenient.

Transformers will be rather smaller. In these the weber-turn is a convenient size and an interesting quantity, as it is given by $\frac{1}{4}$ *of the mean volts per cycle*, or, more accurately expressed, *mean volts per unit frequency* ÷ 4. Its numerical value will lie between, say, $\frac{1}{4}$ and 50, according to the volts and the frequency, but it gives no indication of the size of the transformer.

The henry 10^9 C G.S. is also large. The inductance of choking coils would, in general, be fractions of a henry. The inductance of the winding of a transformer has no very important meaning, but it has a convenient size. Measuring it as *mean volts of unit frequency ÷ four times the open-circuit current in amperes*, the inductance of the primary coil on a 2-h.p. closed magnetic circuit 1,000-volt transformer would be about 40 henries.

The inductance of pairs of cables would run from 100 to 1,000 micro-henries per kilometre, but the value would vary with the arrangement.

The induction per unit area is good ; having a value in practical work from 1,000 to 20,000 C.G.S. units it is given by 10 to 200 microwebers per square centimetre.

Gaussage would be about 50 in small transformers, up to 40,000 in large dynamos. The latter could be conveniently reckoned in kilogausses. To make the gauss = one ampere-turn appears to have great advantages in practice, and connects it directly with its usual source.

The idea of permeance is very useful, and the identification of its dimensions with those of inductance is neat. But I think it is liable to cause confusion, for the permeance of the core of a coil will be a different number of henries from the inductance of its wire. Moreover, the argument as to identical dimensions might equally be applied to the case of amperes and gausses. I would therefore have a new unit strictly connected with the henry, so that inductance = n^2 × permeance in a coil of n turns.

As to the units of permeance : with the above meanings of gauss and weber the permeance of a circuit would be $4\pi\mu A/10l$, as you point out, instead of $\mu A/l$. But I wish to suggest a change in the method of reckoning—namely, still to retain the value of the permeance as $\frac{\text{webers}}{\text{gausses}}$, and permeability as $\frac{\text{webers per sq. cm.}}{\text{gausses per cm.}}$, therein giving up the convention of unit permeability of space, and giving it the value $1{\cdot}2566 \times 10^{-8}$ unit of permeance for a unit cube. In this way both the troublesome 10^{-8} and $4\pi/10$ are dealt with in an easily intelligible way. To avoid the high power of 10 it may be measured in micro-units of permeance, so that permeability of space and air = ·012566 micro-unit of permeance for a unit cube, and permeability of soft iron = up to 25 micro-units for a unit cube. Thus we have permeance = $A\mu/l$, where μ is to be obtained from tables of its value, which can easily be altered to this method. Inductance then becomes $\frac{\text{weber-turns}}{\text{amperes}}$, or $n^2\,\frac{\text{webers}}{\text{gausses}} = n^2$ permeance.

[Of course, your phrase "weber-turns per ampere" means the same as the above webers ÷ amperes, and does not necessarily mean the weber-turns caused by one ampere.]

It may be objected that the C.G S. units of strength of field, unit of magnetic pole, and intensity of magnetisation do not bear any simple relation to these practical units. This is chiefly important in the use of the magneto-metric measurement of iron, and in the measurement of the mechanical form of attraction between two magnetic surfaces in contact. But the expressions are not in reality much complicated—*e.g.*, present C.G S. unit of intensity of magnetisation is given by $4\pi I = (\mu - \mu_s) H$ where μ_s = permeability of space = 1, and H = C G.S. unit of magnetic force This becomes $4\pi I = (\mu' - \mu'_s) H' 10^8$, where H' is the gauss-gradient in the magnetic substance, and μ'_s = ·012566 micro-unit of permeance for a cubic centimetre.

As the single magnetic pole is unchanged, the force on it will be = strength of pole × gauss-gradient × 1·2566 ; but as this is not a calculation of frequent occurrence, except in magnetic surveys, the complication will not be serious. Other magnetic relationships are almost entirely of academic interest only, and would be carried out in C.G S units. Also, the transition would present no difficulties to people with a little scientific knowledge.

I am of opinion, also, that as the legal volt has no direct connection with induction and velocity of motion, it is not necessary to define the practical units as they are defined absolutely—that is, ohm and ampere are the starting points, volt is obtained from them, weber from volt, gauss from ampere, permeance unit from weber and gauss, henry from weber and ampere or from permeance, and so on This is much more easily explained to practical and unscientific men than the absolute derivations are, and it is the order in which they learn them.—Yours very truly,

FRANCIS G. BAILY.

Postcript.

Another subject for discussion is whether L had better not be defined as $d\,N/d\,C$; with permeability as $\mu = d\,B/d\,H$ to correspond. This would make the three preceding equations stand thus :

$$(1)\ N = \int L\,d\,C.$$

$$(2)\ E = L\,\dot{C}.$$

$$(3)\ \dot{W} = C\,\dot{N}.$$

A letter just received from Mr. Heaviside indicates that he would probably favour this course, and there is evidently much to be said for it I need hardly add that he contemns my temporising method of dealing with the 4π nuisance.

January 30, 1895. O. J. L.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Posen.—Tenders are invited by the State Railway Authorities for the supply of 90,000 carbon pencils. Conditions for 50pfg. from Die Königl. Eisenbahn-Direktion, Posen.

Ploesti.—The Municipality of Ploesti invites tenders by January 15 for the lighting by electricity of the 46 principal streets in the centre of the town. Conditions from La Mairie de Ploesti, Roumania.

Brussels.—The Ministère de la Guerre invites tenders by January 15 for (1) a heating installation, (2) electric lighting in the new military school to be constructed in the Avenue de la Renaissance, Brussels.

Aussig.—The communal authorities propose to have built a seven-mile single line tramway. The choice of system is left open. Contractors are invited to place themselves in communication with the Stadtrath, Aussig-a.-d.-Elbe, Prussia. Tenders are to be in by January 31.

Wigan.—The Corporation invite tenders for the erection of a dynamo-house and boiler-house for the generating station of the proposed Corporation electric lighting works, for the Gas and Electric Lighting Committee. Drawings may be inspected, and copy of specification, conditions of contract, and bills of quantities obtained, on depositing £2. 2s., which will be returned on receipt of a bona fide tender, on application to Mr. Jos. Timmins, engineer, Wigan. Tenders, sealed and endorsed "Dynamo-House, etc.," to be addressed and delivered to Mr. J. J. Charnock, town clerk, by 20th inst.

St. Pancras (London).—The Vestry invite tenders for the wiring and other work in connection with the electric lighting of the Vestry Hall and offices in Pancras-road. Specification and conditions of contract can be obtained at the Electricity Department Offices, 57, Pratt-street, N.W., on payment of £1, which will be returned on receipt of a bona fide tender; and a plan of the general positions of the lights can be inspected at the office of the borough engineer at the Vestry Hall, Pancras-road. Tenders to be sent to Mr. Albert E. Pycraft, chief clerk, Electricity and Public Lighting Department, 57, Pratt-street, N.W. endorsed "Tender for Wiring Vestry Hall and Offices," by 12 noon on the 16th inst.

Shoreditch (London).—Tenders are invited for the supply and erection of buildings, including an engine-house, offices, and building enclosing dust destructor (the dust destructor being included under another contract), for the Vestry of St. Leonard, Shoreditch. Specifications, bills of quantities, and forms of tender, and any additional information can be obtained from the engineers, Messrs. Kincaid, Waller, and Manville, of 29, Great George-street, Westminster, S.W., on payment of £3. 3s., which sum will be returned when a bona fide tender is received by the Vestry. The plans can also be inspected by intending contractors at the offices of the engineers. Sealed tenders shall be sent to Mr. M. Mansfield Robinson, Shoreditch Town Hall, Old-street, E.C., endorsed "Electric Light Station, Tender for Buildings," at or before noon on 20th inst. The contractor whose tender is accepted shall enter into a formal contract under seal with sufficient sureties for the fulfilment of contract.

RESULTS OF TENDERS.

Cambridge.—The tender of Mr. J. O. Vinter, Hills-road, at 13s. 6d per ton for the supply of 1,000 tons of steam coal for the Cambridge Electric Supply Company, Limited, has been accepted.

Loughborough.—The Town Council have accepted the tender of the Brush Company to supply a dynamo and engine for £80, and lamps and fittings for £43. 2s. 6d., in accordance with specifications.

Islington (London).—The tender of Messrs F. A Glover and Co. for electric lighting of the Agricultural Hall has been accepted. Besides incandescent lighting there are to be 45 arc lamps, together with large mains for supplying current for the various exhibitions.

BUSINESS NOTES.

Great Northern Telegraph Company.—For the month of December the receipts were £26,000

Macroom (Cork).—It is stated that Messrs. Baldwin and Co. and other shopkeepers intend adopting the electric light.

Portsmouth.—Orders have been given for lighting the workshops in Portsmouth Dockyard throughout with electricity.

Bilston.—The new baths are lighted throughout by electricity, the plant for generating the current being fixed in the basement.

Newport (Salop).—The Urban District Council are about to take into consideration the question of lighting the district by electric light.

Vacancy.—The Wolverhampton Corporation require an assistant and draughtsman in the office of the electrical engineer. The salary is £100.

Eastern Telegraph Company.—The receipts for the month of December were £71,577, as against £55,598 for the corresponding period of 1894.

Agency.—Mr. H. Grunwell, M.I.C.E., has been appointed by Isles, Limited, Stanningley, Leeds, their London agent for steam and hand cranes, etc.

Clacton-on-Sea.—Notice of motion has been given to the Urban District Council to the effect that proposals be invited for an installation of the electric light at Clacton-on-Sea.

City and South London Railway.—The returns for the week ended January 5 were £1,017, compared with £1,003 for the corresponding period of last year, being an increase of £14.

Worcester.—The Finance Committee of the City Council have recommended the issue of further Corporation stock to raise £1,300 for the electric lighting of the Guildhall and public hall.

West India and Panama Telegraph Company.—The receipts of the Company for the half-month ended December 31 were £2,639, against £1,949 for the corresponding period of last year.

Sheerness.—The activity at the Sheerness Dockyard has been for the past few weeks abnormal, and the electric light has been fitted to the ships and docks to enable the employés to work overtime.

Globe Telegraph Trust.—The directors of the Globe Telegraph and Trust Company, Limited, have declared an interim dividend of 3s. per share on the preference and 1s. 6d. on the ordinary shares.

Bangor (Wales).—The Town Council have decided to apply to the Local Government Board for sanction to borrow £15,000 for the purpose of providing an electric lighting plant for the borough.

Rochdale.—The Town Council have decided to make application to the Local Government Board for sanction to borrow £500 for the purpose of lighting the free public library with electricity.

Newcastle.—A meeting of ratepayers has been called to consider the question of the offer made by the British Thomson-Houston Company, Limited, to equip and work the tramways by means of electricity.

Western and Brazilian Telegraph Company.—The receipts for the week ending January 3, after deducting 17 per cent. payable to the London Platino-Brazilian Telegraph Company, amount to £2,640.

India.—Schemes have been sanctioned for a telegraph line from Howrah to Cuttack and from Midnapur to Sini at a cost of about 3¾ lakhs of rupees, and along the Delhi Batinda-Samasata line at an outlay of about four lakhs.

Yeadon (West Riding).—The District Council having taken the opinion of the ratepayers on the question have decided not to adopt electric lighting. More than half the number of the voting papers were returned in blank.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending January 5 amounted to £1,150, as compared with £926 in the corresponding week of the previous year, being an increase of £224

The Stock Exchange List.—Application has been made to the Stock Exchange Committee to allow the St. James's and Pall Mall Electric Light Company, Limited, £50,000 4 per cent. debenture stock to be quoted in the official list.

Helios-Ehrenfeld Aktien-Gesellschaft.—The general meeting has decided to increase the Company's capital to 3,000,000 marks. The *Elektrotechnischer Anzeiger* says that the net profits amount to 165,000 marks, so that an 8 per cent. dividend is possible.

Telegraphs in Siam.—The head of the Siamese Public Works Department has left Bankok for Tavoy to enquire into the constant telegraphic interruptions between Burma and Siam, and to make arrangements for improving the maintenance of the line.

Submarine Cable in Cuba.—The Spanish Government has laid a submarine cable connecting the principal ports of the island in order to avoid the delay in the transmission of news caused by the cutting of the land wires by small groups of mounted insurgents.

Clontarf.—The Southern District Tramway Company have applied to the Commissioners of the Clontarf Township for permission to extend their electric tramway into the city. The Board have not yet given their consent, but they have expressed their approval of electric traction.

Newcastle.—Mr. Laws, the borough engineer, Alderman Winter, chairman of the Town Improvement Committee, and Mr. Morton, chairman of the Tramway Committee, have been instructed to proceed to Bristol to examine the electrical railway laid there, and report to the Tramway Committee.

A New South American Cable.—A new concession has been applied for to establish a submarine cable, which, starting from Monte Video, shall cross to Buenos Ayres, and then pass down the coast of the Argentine Republic to Santa Cruz, from which point it is intended that it shall strike across to the Falkland Islands.

Eastern Extension Telegraph Company.—For the month of December the receipts show an increase of £9,348, as compared with the corresponding period of 1894. The interest on the 4 per cent. mortgage debenture stock for the half-year to January 31 will be paid on February 1. The stock-register will be closed from 28th to 31st inst., inclusive.

The Export Merchant Shippers' Directory.—We have received from Messrs. Dean and Son, Limited, 160A, Fleet-street, a copy of the thirty-first annual issue of the Export Merchant Shippers' Directory. The section dealing with firms who manufacture principally for export has been augmented, and the number of pages shows an increase on last year.

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Cheltenham.—The Lighting Committee have reported to the Town Council that during the past month 750 8-c.p. electric lamps have been connected with the town supply, bringing the total up to 5,050, while 500 more were awaiting connection.

Metropolitan Asylums Board.—The Board have received the assent of the Local Government Board to their entering into contracts with Messrs. Siemens Bros., Limited, and Messrs. J. H. Holmes and Co. for the execution of works in connection with the installation of electric light at the Brook Hospital without, in the first instance, advertising for sealed tenders.

Catalogue.—The annual price-list of the Chloride Electrical Storage Syndicate, Limited, comes, as usual, in the form of a neat morocco bound pocket book. Besides lists and descriptions of the chloride cells, it contains careful directions for their erection and working, and a number of tables useful to electricians. It is a well got-up little volume and is properly indexed.

Lincoln.—The Town Council have refused their consent to the grant by the Board of Trade of the provisional order for which the County of London and Brush Provincial Electric Lighting Company, Limited, have given notice of their intention to make application, and a special committee has been appointed to consider and report upon the advisability of supplying electricity in the city of Lincoln.

Direct United States Cable.—The Board of the Direct United States Cable Company, Limited, have resolved upon the payment of an interim dividend of 2s. per share, free of income tax being at the rate of 2 per cent. per annum, for the quarter ending December 31, such dividend to be payable on and after the 24th inst., setting aside £10,000 to reserve fund account, and carrying forward a balance of £4,148. 14s. 4d.

Brussels.—It is stated that, in order to prevent the cost of wiring deterring customers from adopting the electric light, the Brussels authorities have decided to wire consumers' houses at their own expense and recoup themselves by an annual charge added to the bill. One incidental advantage of this system would be that the supply company would no longer be able to complain of bad work inside the consumers' premises.

Ripon.—The City Council have received a communication from the Board of Trade, intimating that, as requested by the Council, they had given notice to Messrs. G. Harrison and Co (who are now supplying the electric light to the Cathedral) requiring them to carry out their works in the city in accordance with the regulations of the Department The Gas Committee have under their consideration the question of lighting the city by electricity.

Blackpool.—It is stated that there will be opposition to the Corporation's Improvement Bill which includes a new line of electric tramways. The Electric Lighting Committee has been reduced to nine members instead of the whole Council. Mr Hesketh was appointed to superintend Messrs. Fowler's contract for the extensions. The Town Council have remodelled the discounts allowed on the 6d. per unit charge for the Corporation's supply of electricity.

Stourport.—The committee which had been appointed to consider the proposed electrical tramway scheme unanimously recommended to the Urban Council that steps be taken to safeguard the public interests. The report was adopted. There appears to be no desire to oppose the Bill generally, but only to see that certain details are altered. It will be necessary to call a special meeting of the Council and a meeting of ratepayers to authorise the expenditure of money for this purpose

Chelsea (London).—The Guardians have received 12 tenders for an electrical wiring installation with fittings in the infirmary extension. Mr. Brass suggested that the tenders should be sent to Mr. Blose and other gentlemen to confer with the architects, as such tenders needed carefully going through. If they accepted the highest tender, it might prove the cheapest, and if the lowest, it might prove the most expensive. Ultimately it was decided to refer the tenders to the General Committee for report.

Leeds.—The Leeds Tramways Committee have decided to visit Westminster for the purpose of inspecting the working of the Westinghouse Electric Company's system, which Dr. Hopkinson suggests should be adopted in those parts of the city where poles and overhead wires are deemed undesirable They expect to be able to lay a definite scheme before the Council early in February. Dr. Hopkinson's report, which proposes an expenditure of nearly £38,000, will be given at length in our next week's issue.

Bristol.—The Sanitary Committee have received a communication from the tramway company with reference to their provisional order for tramway extension, and a separate application in respect of overhead electric traction from Trinity road to Eastville, and have decided to oppose the order in those particulars outside the existing agreement with the committee. As to the proposed extension to Eastville, it was agreed to defer discussion on the subject until a definite proposal had been brought forward.

Calendars.—Among the calendars for 1896, the receipt may be noted of Messrs. Willcox and Co's "Date Remembrancer." This is illustrated with a view of their works in Southwark-street, and some of the more important of their fittings and stores. A similar calendar comes from Messrs. Sankey and Son, Canning Town, E The eleventh annual issue of the "Columbia Calendar" is quite an artistic and handy production, and should appeal to cyclists particularly. It is manufactured by the Pope Manufacturing Company, of Hartford, Conn.

New Companies.—Among the companies registered during December were the Direct Electric General Syndicate, Limited, capital £100,000; Electric Insulation Syndicate, Limited, £10, £5,000; Electric and General Exploring Syndicate, Limited, £5,000; Lightning Express Railway Syndicate, Limited, £100,000; Madeira Electric Lighting Company, Limited, £20,000; New Electric Light Syndicate, Limited, £2,000; Road Motor Association, £1, £15,000; Woking Electric Supply Company, Limited, £1 £20,000; Windsor Electrical Installation Company, Limited, £1, £10,000

Derby-to-Ashbourne Tramway.—The Bill for this electric tramway has been deposited. The company will have a share and loan capital of £87,500 The promoters of the Bill are Sir Henry Wilmot, Bart., V C., C B., the Hon. Frederick Strutt, Mr. Alfred Charles Duncombe, Mr. Godfrey Tranceys Meynell, and Mr. John Shaw, who, with "one other person," to be nominated by them, are to be the first directors of the proposed new company. The Bill contains power to enable the company to pay interest out of capital during the construction of the tramway to an extent not exceeding in the aggregate £10,000.

Edinburgh.—Palmerston-place United Presbyterian Church is the first church in the city to adopt the electric light. The current is obtained from the town's supply, and the scheme of lighting is in accordance with plans prepared by Mr George Balfour, late of the Corporation electric light station, the contractors for the installation being Messrs. Lowdon Bros., Dundee. In all there are 170 incandescent lamps in the building varying from 16 c.p. to 32 c.p. On the report of the Electric Lighting Committee, recommending extensions, coming before the Council, the question was remitted to the Street-Lighting Committee for report.

Sheffield.—The Sheffield Tramways Company are promoting a Bill for power to take up the old tramways and relay them for electric cars, but the Bill provides that the powers of the company to do this shall be suspended for three months from the passing of the Act, so as to give the Corporation within that time an opportunity to decide whether they will be substituted in the place of the company, and work the line themselves. The Bill enables the Corporation, if they think fit, to grant a lease to the company for any term of years, whether exceeding 21 or not. Another Bill seeks to lay down additional tramways in Sheffield at an expenditure of £600 000.

Addresses.—Mr. B. H Thwaite civil engineer and metallurgist, has opened a Westminster office at 29, Great George street, S W.—Messrs Dorman and Smith, manufacturing electrical engineers (Salford), have moved their London office from 11, Grocers' Hall-court, Cheapside, E C., to 94, Charing Cross road, W.C.—Mr. C A. Hemingway, of 10, Petersham-road, Richmond, Surrey, who has carried out a number of installations in Richmond and the neighbourhood, in order to meet the increased demand of his London connection, has opened offices at 39, Victoria-street, Westminster, S.W. Both the Richmond and London office will be connected to the National Telephone Company's system.

Chelmsford.—In reference to the fire at the Arc Works and the lighting of the town, Councillor Britton, at the meeting of the Town Council, said the electric lighting company had endeavoured to do everything they possibly could, and in trying to please everybody they seemed to have pleased nobody. The traders of the town were entitled to some consideration in the matter of lighting, and this they got, but the traders broke faith with the company, with the result that there was neither public nor private lighting on Christmas Eve, when it was much needed. Everything possible was, however, being done, and it was hoped shortly to have all the lights, both public and private, running satisfactorily.

The Transvaal Government.—"One Who Knows" writes to the *Standard* defending the action of the Government of Pretoria in interdicting the use of English plant in its electric lighting. "The electric lighting of Pretoria," he says, "under Government management, has been in full operation for more than two years; but the original plant, which was sent from England, proved to be of very inferior quality, and is already worn out. It is but natural, therefore, that the Government of Pretoria should get their new plant from some other country." The implication that English firms cannot be found who will supply a good installation shows how hard put to it for an excuse the friends of the Boer Government must be.

Sheffield.—The solicitors to the Sheffield District and Rotherham Tramways Company are asking the Corporation for a lease for the existing tramways for 28 years They offer to continue the payments now made by the existing tramway company, amounting altogether to £2,985 7s 8d per annum, and to pay in addition during the 28 years £6 500 per annum; to reconstruct the existing lines of the Corporation for the purpose of electric traction, at an estimated cost of £54,000, the whole benefit of which will at the expiration of the lease revert to the Corporation without payment; and, further, to extend the tramways by the construction of an additional 19 miles at an expenditure of over half a million of money. The system the company propose to adopt is that of overhead electric traction.

Belfast.—On the report of the Electric Lighting Committee coming up in the Town Council, Councillor Andrews, replying to questions, said that the new engines would probably be delivered in the early part of February, and he did not think it would take long to get them into working order With regard to a question as to there having been no statement of the income of the committee, the Lord Mayor himself had stated in his address that the electric installation up to the present, or up to the end of the year, had shown an actual working profit of about £300 or £400. All the demands the committee were capable of complying with had been complied with. In answer to a further question by Councillor Young, Councillor Andrews said the new dynamos would be driven direct; the others were couple-driven by ropes.

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Hampstead (London)—The Vestry have decided to lay mains for the supply of electric current to private consumers in Redington-road, Goldhurst-terrace, and Canfield-gardens. In reply to a question, it was stated that the cost of the globes affixed to the arc lamps in Finchley-road was 15s. each An offer was made by a firm to supply them for 12s. each, but the committee had been unable to obtain any at that price The care of the arc lamps has been handed over to Messrs. Siemens for eight weeks in accordance with the arrangement sanctioned at the previous Vestry meeting Mr. Evans, as a private consumer, enquired as to the cause of the stoppage of the light on Monday evening last week, and the engineer said that the stoppage was due to the fact that a fuse in one of the machines at the central station blew out and was not noticed as quickly as it should have been.

Weybridge.—A sub-committee of the Urban Council have met Mr. Martindale (representing the Weybridge Electric Supply Company) at the offices of the Board of Trade, and had an interview with Sir Thomas Blomfield to discover if, in the event of the Council purchasing the provisional order, the operation of it could be suspended for, say, three years. Sir Thomas Blomfield replied that the Board of Trade had no power to grant permission for suspension of the order. He further stated that it was open to anyone to apply for another order on the annulment of that now held by the Weybridge Supply Company, that the probable cost of a new order would be £200, and that it would take 12 months to obtain one. Under these circumstances, the committee recommended the Council to discontinue the negotiations for the acquirement of the Supply Company's provisional order. It is possible, however, that a purchaser has been found for the company's undertaking, and, if so, there is a strong probability that the cables and wires will soon be in use again in Weybridge.

Alsager (Stoke-on-Trent).—The Urban District Council have again discussed the question of lighting the village. Mr. J. Maddock, J.P., in accordance with notice of motion, moved that it was desirable to light the village by electricity, and that steps be taken for that end during the present year. Such a scheme would, in his opinion, be of advantage to the village and the ratepayers generally. He thought it would be a backward step to adopt gas-lighting. Mr. Barker seconded the motion. Mr. Cotton moved as an amendment that a poll be taken of the village, which was seconded by Mr. Morris: but after a short discussion the amendment was withdrawn, the original motion being carried. Mr. Cotton then moved that no steps be taken in the matter until the ratepayers had been consulted, this being the condition upon which he withdrew his amendment Mr. Morris also seconded the resolution, which was carried unanimously. The resolution is consequent on a report of Mr. G. R. Peers, A.I.E.E., consulting engineer, of Manchester, who has visited the district, submitted a scheme for the proposed installation, and also addressed a ratepayers' meeting.

Bristol.—The Stapleton Urban District Council have resolved that the chairman and clerk should together formulate and forward to the Board of Trade the Council's ground of opposition to the provisional order sought by the Great Western Electric Light and Power Company for powers within the district. The Chairman (Mr. Daniell) mentioned that he had received a letter from Mr. D. Travers Burges, on behalf of the Bristol Electric Lighting Committee, stating that, as the Corporation were proprietors of an electric lighting undertaking within the district, his committee had requested him to enquire whether the Council intended to oppose the application of the company referred to, and, if so, as to the nature of such objection. The Chairman said he scarcely thought they should be asked to give the information asked for by the town clerk There was a large question behind this matter—the question of boundaries—and Bristol of course, did not want them to enter into any arrangements with the company while they were desirous to take Stapleton into Bristol. It was decided that the clerk should reply to the letter that the Council had the matter under consideration.

Langhans-Berrenberg-Chaplin Patents, Limited.—This Company was registered on December 31 by Templer, Down, and Miller, 3, Pope's Head-alley, E.C., with a capital of £175,000, divided into 175,000 shares of £1 each. Object: to adopt and carry into effect an agreement expressed to be made between Albert Myers Gibson, on the one part, and this Company of the other part; generally to carry on the business of manufacturers of incandescent or other electric lamps, and of all filaments, wires, bulbs, and other parts and requisites of such lamps; to manufacture all such pumps, plant, and appliances as may be necessary to or useful in the manufacture of such incandescent lamps or parts thereof, and to carry on the business of an electric light company in all its branches; to construct, lay down, establish, fix, and carry out all necessary cables, wires, lines, accumulators, lamps, and works; also as mechanical and general engineers, etc. The signatories are: H. L. Pilkington, 76, Jermyn-street, S.W.; P. J Miller, 3, Pope's Head-alley, E C; T. L. Down, 3, Pope's Head-alley, E.C.; W. A. Smithe, 6, Old Jewry, E.C.; D. S. Porteus, 23, Eccleston-square, S.W.; A da Costa, 16, Hyde Park-gate, S.W.; W. Wallace, 27, Old Broad-street, E.C. The registered office is 3, Pope's Head-alley, Lombard-street, E.C.

Brighton.—The new electric elevator at the town hall was supplied by the Otis Elevator Company, Limited, and is one of the best and largest of electrically-driven lifts erected in this country. The car is 6ft. by 6ft., and will accommodate 12 passengers at one time. It is operated by four of the best wire cables ¼in. in diameter—two for lifting and two for independent counterbalance—each capable of sustaining a load of 8,000lb. Two of these cables are independently attached to the safety appliances under the car, which are so arranged that the breakage of one or both of the cables will immediately lock the car firmly upon the guides and prevent its descent, while allowing of its being raised. There are other patent automatic safety appliances attached to the car and to the electric motor, which is situated at the top of the shaft, to provide against obstruction or anything untoward happening. The lift has been built at a cost of about £550, and is a part of the alterations to the town hall, which are now being carried out in accordance with plans prepared by Mr. May, the borough engineer and surveyor. The electric lighting of the main streets has proved a great success, and the Electric Lighting Committee of the Corporation have now under their consideration a scheme for extending the system to many of the less important thoroughfares.

Pole-Finding Paper.—We have received another example this week of those small things which tend to make the electrical engineer's professional life easy. A pole finding apparatus is not so very often required but when it is wanted it is essential that some handy and reliable method should be at hand. The old and cumbersome devices of polarised voltmeters and electrolytic cells are much too cumbersome and costly to compete against the more recent pole-finding papers. The sample we have before us was manufactured by Mr. A. H. Avery, of Tenterden. It is not absolutely a new invention, but careful investigation has resulted in a paper which is very sensitive and absolutely non-poisonous. Its sphere of utility is not confined alone to electrical manufactories or lighting installations for it will be found of great value to amateurs in all kinds of electrical experimental work. By the use of one of these "pole finders" the possibility of wrong connections may be entirely avoided, and such things as reversals of dynamos, motors, accumulators, etc., which are sometimes costly mistakes, will then with care become things of the past. This paper, when moistened and placed across the poles of the dynamo or battery, shows a black mark at the positive pole. We feel sure that this article will find a ready demand, and will in some measure reduce the troubles of all electrical engineers.

Waterloo to Baker-street Railway.—The promoters of the authorised electric railway from Waterloo to Baker-street have deposited a Bill for next session, under which Parliament is asked to authorise a short but important extension westward, in order to effect communication with the Manchester, Sheffield, and Lincolnshire Railway Company's extension to London, and thus give direct access between Waterloo and the terminal station of that company. The Bill also proposes to give power to the former company to enter into working agreements with the London and South-Western Railway Company, the Manchester, Sheffield, and Lincolnshire Railway Company, the Metropolitan Railway Company, and the Waterloo and City Electric Railway Company. By Clauses 11 and 12 of the Bill the original scheme of constructing this railway, as a whole, is proposed to be modified by constructing the railway as three separate "undertakings," each having a separate and distinct capital. "Undertaking" No. 1 will comprise the line from its western terminus to the southern end of Langham-place, and have a share capital of £330,000. "Undertaking" No. 2 will commence at the southern end of Langham-place and terminate at the southern end of Regent-street, and have a separate share capital of £270,000. "Undertaking" No. 3 will consist of the remaining portion of the scheme to Waterloo Station, and will have a separate capital of £650,000. The time for the completion of these railways, as originally authorised, is sought to be extended until March, 1901, which is three years beyond the time originally granted. During the period of construction it is now proposed to pay interest out of the capital allocated to each separate undertaking, provided that the aggregate amount so paid does not exceed in the whole £120 000. In consequence of the powers sought in this Bill, it is proposed to increase the authorised share and loan capital of the company from £1,666,000 to £1,766,000.

Wallasey (Cheshire).—On the Gas and Water Committee's report coming up for confirmation in the Urban District Council, Mr Ellery, in moving its adoption, said the engineer now proposed to establish a trunk line for the electric lighting of the district. The scheme provided for nearly the whole of the district, and would cost £12,500. For this they would have plant on the high-tension alternating-current system, working at 2,000 volts, reduced by transformers to feed low-pressure mains. Transformers would be fixed at New Brighton, Egremont, Seacombe, Liscard, and Wallasey. The generating station would be on the site of the Liscard pumping station, with mains through Liscard, down Manor-road, Seabank-road, Rowson street, and Victoria-road; also along Warren-drive and Grove road to Wallasey Station; Manor-road, King-street, Trafalgar-road, Brighton-street, and Church-road to Seacombe Ferry. He hoped the Board would appreciate the advantages of electricity and adopt the scheme. Mr. Dunn supported on the understanding that Wallasey village should be included. Mr. Burrows opposed on the ground that the work could not be done for the money. The Chairman also thought it would cost very much more. Mr. Herron strongly opposed on the ground that the work could not be done for less than thrice £12,000. He thought they should have the opinion of an expert and get a proper estimate before entering on the scheme. They had been spending enormous sums of money recently, and this would be a further burden, coming just after establishing new gasworks at a very heavy expense. Mr. Paxton proposed that the question should be referred back until expert opinion was had. Mr. Herron seconded. Mr. Joyce said ample expert opinions had been taken, and the gas engineer was quite satisfied with the accuracy of the estimate. Mr. Ellery, in reply, said they would never have heard anything of the amendment if it had not been that Mr. Herron was taking steps to have the electric light

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at the ferry. The amendment was lost by five votes to fourteen, and the minutes were then passed. Mr. Ellery said if the estimates they would get exceeded the sum named the committee would at once take the Council into their confidence. The report was adopted.

PROVISIONAL PATENTS, 1895.

DECEMBER 23.

24577. **Improvements in movable supports for movable flexible electric conductors.** Thomas Laurie, Wellside-terrace, Falkirk.

24578. **Improvements in the application of electricity to vehicles on tram and railways, and in the apparatus for effecting the same.** David Urquhart and Frank Wynne, 17, Victoria-street, Westminster.

24594. **Improvements in electric lifts.** John Sanders Stevens and Charles George Major, Janus Works, Queen's-road, Battersea, London.

24618. **Improvements in telephony.** Charles Adams-Randall, 63 Chancery-lane, London.

24622. **Mercury gravitation safety-valve and pressure gauge for kitchen and ocrtain low-pressure boilers for electric and machinery engines and water-heaters.** Charles Mackintosh, 159, Euston-road, London. (Complete specification)

24630. **Improvements in dynamo-electric and electro-dynamic machines.** William Hensley Tregaskin, 191, Fleet-street, London.

DECEMBER 24.

24680. **Improvements in electric lighting of cycles, carriages, and other vehicles, and portable and any other lamps.** Phineas Henry Emmanuel and Harry Gage Baker, 12 Ordnance-row, Portsea, Hants.

24706. **System of electric telegraphy and central-station connections and apparatus therefor.** George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London (Wm. H. Cooley, United States.) (Complete specification.)

24710. **Improvements in lightning arresters for high-potential electric circuits.** James Devonshire, 70, Chancery-lane, London (William B. Potter, United States.) (Complete specification)

24711. **Improvements in or relating to electric brakes.** James Devonshire, 70. Chancery-lane, London. (William B. Potter, United States) (Complete specification)

24716. **Improved switch for tramways, electric railways, and the like.** Ludwig Pritzius and Fritz Straube, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24735. **Improvements in electric arc lamps or lighting apparatus.** William Henry Smith, 11, Southampton-buildings, Chancery-lane, London.

DECEMBER 27.

24800. **Improvements in and relating to electric light adapters for oil lamps and candlesticks.** John Black Meiklejohn, 136, Bothwell-street, Glasgow.

24834. **Improvements in electric accumulators.** Charles Théryc and Alfred Oblasser, 45. Southampton-buildings, Chancery-lane, London. (Date applied for under Patents etc., Act, 1883, Section 103, June 28, 1895 being date of application in France.)

34836 **Improvements in electrically-operated windlasses.** Georg Asmussen, 45, Southampton-buildings, Chancery-lane, London. (Complete specification)

24837. **Improvement in the method and apparatus for washing alkali-amalgam obtained in electrolytic apparatus.** Peter Jensen, 77, Chancery-lane, London. (Henrik Christian Fredrik Störmer, Norway.)

DECEMBER 28.

24851. **Development and combination of the telephone and the phonograph.** Jules Ernest Othen Kumberg, 48, Brondesbury-road, Kilburn, London.

24852 **Insulating material for electrical purposes.** Walter Poynter Adams, Furze Cottage, Roehampton, London.

24868. **Improvements in recording instruments for telegraphic and other purposes.** William Thomson, Baron Kelvin, 154, St. Vincent-street, Glasgow.

24884. **Automatic switch for electric water-heater.** John William Ewart and George Ewart, 77, Chancery-lane, London.

24885. **Improved apparatus for electrically controlling the supply of gas and other fluids, and for like purposes.** James Randolph Courtenay Gale, 21, Finsbury-pavement, London.

24888. **Improvements in hinges or joints for electrical purposes.** George William Goldring, 97, Newgate-street, London.

24905. **Improvements in and relating to telephone transmitters.** Thomas Joseph Rorke, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24892. **Improvements in regulators for dynamo-electric machines.** P. R. Jackson and Co., Limited, and Joseph Slater Lewis, 31, High Holborn, London.

24895 **Improvements in dynamo-electric machines.** P. R. Jackson and Co , Limited, and Joseph Slater Lewis, 31, High Holborn, London.

DECEMBER 30.

24945. **Improvements in and relating to carbon-holders for electric arc lamps.** Henry James Fisher, 70, Chancery-lane, London.

24949. **Improvements in electric arc lamps.** Samuel Sealy Allin, 28, Southampton-buildings, Chancery-lane, London.

DECEMBER 31.

25002. **Improvements in electrolytical apparatus.** Richard Heathfield and William Stepney Rawson, 1, Leadenhall-street, London.

25053. **Improved combined portable electric lamp, switch, and battery.** Richard Thomas Glover and John George Glover, 166, Fleet-street, London.

SPECIFICATIONS PUBLISHED.

1887.

14024. **Secondary batteries, etc.** De Benardos. (Second edition.)

1894.

16686. **Galvanic cells.** Vogt.

646. **Voltaic batteries.** Walker and others. (Second edition.)

1895.

148 **Measuring electric currents.** Shallenberger.

1477. **Arc lamps.** Bevis and Binswanger.

2343 **Electric incandescent lamps.** Pope. (Pope.)

2570. **Chandeliers, electroliers, etc.** Meason and Ford.

2604. **Arc lamps, etc.** Crompton.

17495. **Electrical heating apparatus.** Feeny. (H. W. Johns Manufacturing Company.)

19862. **Dynamo-electric machines.** Devonshire. (Thomson.)

20215. **Galvanic batteries.** Boynton.

20216 **Galvanic batteries.** Boynton.

20306 **Storage batteries.** Langelaan.

20431. **Secondary batteries.** Rooney.

20807. **Electrotypes or galvanos.** Mayer.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	8	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2	1⅞-2
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6⅞-7½
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	12⅜-13½
—— 6 per cent. Cumulative Pref.	10	15½-16
—— 5 per cent. Debenture Stock	100	131-135
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	128-130
—— 5 per cent. Pref. Shares	10	14⅜-15½
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10½-11
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1⅝-2
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅝-¾
—— 7 per cent. Cumulative Pref.	2	2-2½
Elmore's Copper Depositing	2	¼-½
Elmore's Wire Company	2	¾-⅞
Fowler-Waring Cables	5	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	13½-14½
—— 7 per cent. Preference	10	15½-16½
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4¼-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	18-19
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge Ordinary	5	7⅜-8½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅜-8⅛
Liverpool Overhead Railway	10	11½-11⅝
—— 5 per cent. Pref.	10	15⅜-15⅞
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅞-1
Metropolitan Electric Supply	10	10-11
—— 4½ per cent. First Mortgage Debenture Stock	100	114-117
National Telephone, Ordinary	5	5⅛-6
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15½-16½
—— 5 per cent. Non. Cum. Third Pref.	5	6¼-6½
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	8¼-9
Oriental, Limited, £1 shares	1	1⅛-1⅜
—— £5 Shares	5	7⅜-8½
—— £4½ shares	4½	6¼-6⅝
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-106
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8¼-8⅜
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	4⅜-5
Westminster Electric Supply, Ordinary	5	8¼-8⅜
Yorkshire House-to-House	5	6¼-7

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NOTES.

Madras Tramways.—The second section of the Madras electric tramways constructed on the overhead system has been opened for traffic.

Legion of Honour.—The names of MM. Henri Moissan and Arsène d'Arsonval appear in the New Year's list of advancements to the grade of officer of the Legion of Honour.

Electric Tramways in Belgium.—According to the Brussels *Moniteur des Finances*, the Ministry of Railways has decided to refuse for the present to authorise electric traction on the overhead system in Brussels in consequence of the objections raised by the telegraph and telephone administrations.

Manganese and Silicon.—A definite silicide of manganese can be prepared by means of the Moissan electric furnace. M. Vigoureux, who has been investigating its properties, states that its composition corresponds to $SiMn_2$. The compounds of silicon with nickel and cobalt previously prepared had a similar formula.

American Motor League.—The newly-elected executive committee of this association has selected Mr. C. E. Duryea, of Peoria, Illinois, as president. The headquarters of the league are at 335, Dearborn-street, Chicago, and its purpose is to advance the interests and use of motor vehicles. It intends to contest adverse judicial decisions, and to influence legislation as to the use of motor vehicles in America.

The South African Cables.—On Wednesday it was announced that there was a breakage in the telegraph cable between Bathurst (Gambia) and Accra, so that news of the Ashanti expedition could only be obtained by way of the Cape and Aden at largely-increased cost. This failure, following so closely on that of the eastern route to South Africa, shows that there is at any time a serious possibility of losing touch with the South African Colonies altogether, in spite of the alternative routes.

Royal Meteorological Society.—The annual meeting of this society was held on the 15th inst. at the Institution of Civil Engineers, Mr. R. Inwards, F.R.A.S., president, in the chair. The report of the council showed that the society was in a satisfactory condition, 34 new Fellows having been elected during the year. Mr. Inwards devoted his presidential address to the subject of "Meteorological Observatories." The address passed under consideration the various types of observatories, including the most recent class—namely, those on high towers. Mr. E. Mawley, F.R.H.S., was elected president for the ensuing year.

Horseless Carriages.—The Highland and Agricultural Society have accepted an offer of the Lord Provost of Perth to give £100 in prizes for horseless carriages. In the *Journal* of the Royal Agricultural Society Mr. F. S. Courtney deals with the applicability of self-propelled vehicles in rural districts where light railways would from their cost be prohibitive. "If a self-propelled vehicle can be produced at a reasonable cost, carrying a moderate load at a fair rate of speed along the ordinary public road, such a vehicle must in most instances meet all the purposes of a light railway at a very considerable saving in first cost." Various sources of power—steam, petroleum, and electricity—are discussed.

Acetylene.—It would appear that in Italy it is considered that there is a future for acetylene as an illuminant, judging by the space devoted in last week's issue of *L'Elettricità* to a description of an apparatus for the production of this gas from carbide of calcium and water which has been brought out by the Società Elettrica Industriale, of Milan. The apparatus consists essentially of two vertical cylinders sliding into each other very much like a small gasometer. It is stated that up to the present no trouble has been experienced from the acetylene attacking brass or bronze taps and fittings, with the formation of explosive compounds, as has been anticipated might possibly be the case.

Lugano Tramways.—The *Gazzetta Ticinese* gives an account of the Lugano electric tramways. The current is generated at Maroggia, 12 kilometres (7½ miles) off Lugano, water power being used, derived from the sources of the Arogni. Alternating currents are used. At the generating station at Maroggia there is a 300-h.p. turbine, and 5,000-volt currents are carried on an overhead line to Lugano, and there transformed to 400 volts, "a pressure which," our contemporary says, "is not dangerous to anyone touching the line." The greater part of the article is devoted to explaining theoretical reasons for preferring alternating to direct currents, and beyond stating that the three-phase system is adopted no further details are given.

Bottle-Labelling Machine.—One great difficulty in designing machines for labelling bottles is to devise a mechanism that will detach the top label from a pile, so that it may be subjected to the action of a paste-roller, and afterwards pressed against the bottle. The *Western Electrician* contains a description and illustration of a machine in which this is effected by a solenoid and core worked by a dynamo, the plunger attached to the core being charged statically by an ordinary glass friction machine. It is found, as might be expected, that the regulation of the slight impulse of static electricity required to attract the top label is a matter of considerable delicacy. The machine is the property of Mr. J. F. Small, of Chicago, one of the inventors.

M. Mondon on Voltage.—In the note in our last issue on the subject of a communication of M. Mondon to the Chambre Syndicale des Industries Electriques, translated from *L'Eclairage Electrique*, the equation given in the last lines is obviously incorrect. M. Mondon is urging that permission should be granted to use alternating currents of 250 volts with bare conductors, and substituting for the figure given 1·41—*i.e.*, the ratio of the maximum pressure to the square root of the mean square—the argument becomes: "Admitting that the danger is proportional, not to the effective but to maximum pressure, there would be in that case only (a maximum of) $250 \times 1{\cdot}41 = 353$ volts instead of the 400 volts which are permitted with a continuous current."

To Brighton in Twenty Minutes.—Mr. Hiram S. Maxim contributes a short article to *Cassier's Magazine* on the possibility of propelling trains at very high rates of speed by electric traction. He points out that by this method accelerated speed does not involve such a progressive increase in the weight of the locomotive as becomes necessary when an attempt is made to increase the speed of an ordinary railway train, and he thinks that with suitably constructed rolling-stock a rate of from 90 to 120 miles an hour might be obtained by electric traction. The main idea of the article is to have special electric lines for fast through passenger traffic, leaving the local traffic to be dealt with as now—by steam locomotives. Passengers might then be taken from London to the sea coast in 20 minutes.

Conduit Tramways.—The operation of the conduit electrical railway on the Metropolitan system at New York

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is being watched with interest by American street railway engineers. As the wet, sloppy weather comes on the real test of the system begins, and *Electrical Industries* (Chicago) says that if it proves satisfactory it will only be a question of time when many cable roads will be changed to electric. Local conditions in many places will, however, limit the use of the underground trolley. "On level streets where the drainage is poor, such systems cannot," our contemporary urges, "be used." As the extremes of the North American climate are more severe than ours, American experience would supply a crucial test so far as weather influence is concerned. Also, the drainage difficulty is one that would not be insuperable in most English towns.

Fusion of Wires.—M. Maurain has presented a note to the Société Internationale des Electriciens on the fusion of metallic wires by continuous currents. M. Maurain says the production of drops on the surface of wires not quite in a state of fusion is generally considered as due to the localisation of the current at the surface of the wire, and to be a consequence of the oscillatory nature of the discharge. He has, however, obtained the droplets with a battery current, and the same results are obtained with a resistance introduced, having self-induction as with one that has little or none. The author suggests that the formation of the drops is a capillary phenomenon produced during fusion, and must be explained in the same manner as the equilibrium figures obtained by Plateau with a liquid in suspension in another liquid of equal density. It is, however, difficult to tell whether the forms obtained in the fusion of wires are forms of equilibrium or unstable forms, the transformation of which has been stopped by solidification.

Birmingham and Midland Institute.—The institute conversazione has been held. There was a large attendance, and many enquiries were made for the horseless vehicle which was to be shown, but unfortunately the adaptors of the Milver batteries to this kind of conveyance were compelled to disappoint the enquirers to a large extent. The carriage, which is of the dog-cart pattern, constructed to carry four persons, possesses as its motive power two Milver primary batteries — the invention of Mr. W. Robatham. The advantage claimed for these batteries is that they economise space and weight by making accumulators unnecessary, and also that the need for charging stations is obviated. These two batteries will move the car, which weighs 1,000lb., at the rate of 12 miles an hour for a distance of 150 miles, but the visitors were not able to judge of their power owing to their having been damaged in transit. The company, however, were able to light the room direct from another lot of their batteries with every success.

Institution of Junior Engineers. — We have received the report of this institution for last year. From comparison of the muster roll at the present time and 12 months ago it is satisfactory to notice that applications for admission to membership, after having received the careful consideration of the council, have resulted in the addition of 56 names to the class of "member," including, however, 17 transferences from the class of "associate." A diminution in the number of associates is accounted for chiefly by these transferences, which were duly made in accordance with the resolution passed at the last annual general meeting, whereby candidates over the age of 26 years may be admitted as "members." The total elections and transferences have been 90, while by death, transferences, resignation, and removal of names the number is 45, resulting in a net increase of 45, the total membership being now 418. So far as finance is concerned, the institution started the year with a small deficit, which has now been converted into a small balance to credit.

Electro-Harmonic Society. — The next smoking concert of this society is fixed for Friday, January 31 at the St. James's Hall Restaurant, Regent-street, W., at eight o'clock. The following will be the programme:— Part I.: duet, "The Battle Eve," Mr. Maldwyn Humphreys and Mr. David Hughes; pianoforte solo, "Menuetto and Finale from Op. 31, No. 3" (Beethoven), Mr. Alfred E. Izard; song, "Mary Adeane," Mr. Maldwyn Humphreys; song, "Revenge," Mr. David Hughes; violin solo, "Ave Maria," Mr. T. E. Gatehouse; serenade, "Aubade," Mr. Albert James; humorous sketch, "A Peculiar Party," Mr. Edward Kent. Part II.: violin and piano, "Andante con Variazioni—Finale" (from the Kreutzer Sonata), Mr. T. E. Gatehouse and Mr. Alfred Izard; song, "By the Waters," Mr. Maldwyn Humphreys; song, "A Soldier's Song," Mr. David Hughes; violin solo, "Hungarian Dances," Mr. T. E. Gatehouse; old song, "Oh! Say Not Woman's Heart is Bought," Mr. Albert James; duet, "Flow Gently, Deva," Mr. Maldwyn Humphreys and Mr. David Hughes; humorous sketch, "Harmony Hall," Mr. Edward Kent.

The American Way.—According to *Invention*, one of the quaintest adaptations of electricity, or, rather, electrical appliances, has recently been made in Chicago. On the line of the electric street railway company in that brand-new metropolis is the great cemetery of Oakwood. Heretofore, funerals have taken place in the normal manner by the means of hearses and the accompaniment of mourning coaches. Now, however, the enterprising tramway company is building funeral cars. These above the tracks will be black; even the trolley poles will be wound with crape. When the deceased is a child, this crape will be white and the sides of the car will be festooned with white. Inside the car, just behind the motorman, a bier will occupy one side. Opposite this are to be seats for the minister and pall-bearers. The mourners will sit along the sides of the car. Funeral parties may charter a train with any number of cars, which will start from any point on the line. A special motorman and conductor will be uniformed in black. Funerals run by electricity are certainly a novelty, and the announcement is somewhat startling to our sense of convention.

Safety Rules.—The absence of a regulating authority as to electrical installations in the United States does not give unqualified satisfaction to the Chicago *Electrical Journal*. Under the system of *laissez faire* the matter practically falls into the hands of the insurance companies. The National Board of Fire Underwriters appreciates its position and keeps up with the times, but it is not all-powerful. Many manufacturers find that much of the material they have on the market is accepted by one office and rejected by others, and users are often compelled to take out material and substitute something else after it has been passed by one or more inspection departments. Inspectors of different authorities cannot be brought to agree. On the other hand, with some sort of national Board, if possible, or, at any rate, one made up of State or municipal representatives, there would be a testing department of men whose knowledge and integrity would be above suspicion. Rules for installation would then be alike everywhere, and it would no longer be necessary for manufacturers to keep in touch with an infinite horde of independent inspectors working under different sets of rules.

Foreign Exhibitions.—The Swiss National Exhibition begins at Geneva on May 1 and terminates on

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October 15. Mr. Theodore Turrettini, Mayor of Geneva, and a distinguished electrical engineer, is president of the exhibition, and it is expected that the electrical exhibit will be one of the finest ever seen. Mr. Turrettini has recently completed great engineering works near Geneva, whereby the River Rhone supplies 12,000 h.p., to be electrically transmitted six miles to the grounds. This enormous force makes it possible for electrical experiments to be made which cannot be attempted elsewhere. There will be a travelling footpath, operated by electricity, traversing the great machinery hall; horseless cabs driven by electricity, appliances for aerial navigation, a multiplying valve pump, processes for making paper and fabrics, tests of strength on metals, and many other electrical appliances. Prof. Pictet will display his inventions for producing intense cold, showing a temperature of 415deg. below zero, and will exhibit the uses of this low temperature. The Department of Science and Art has received, through the Foreign Office, a communication from her Majesty's Consul at Barcelona stating that it is proposed to hold a fine art and industrial exhibition in that city, beginning on April 23 next. The Science and Art Department has also received, through the Foreign Office, a communication stating that an international exhibition will be held in Brussels in 1897. There is also to be an industrial exhibition in Guatemala next December.

The Rontgen Radiations.—Further information comes from Berlin on the subject of the new radiations contained in the light from a Crookes vacuum tube which were discovered by Prof. Röntgen, of Wurzburg, by their action on a sensitised photographic plate. On reading of the discovery, the German Emperor promptly invited Prof. Röntgen to Potsdam, and the latter gave there a demonstration of the new radiations. He photographed objects which were placed behind panels of wood, and in wooden and cardboard boxes, the rays which photographed the objects passing through the wood or cardboard. The experiment of photographing the human hand was, however, not repeated. On the occasion when this was done before it was stated that an image of the bones only was produced, the flesh not showing, but it must be remembered that the photographs are not camera images but direct "shadow" pictures, and the source of the light—a Crookes tube—is very far from being a mere point. It is stated that the new radiations are not affected by a glass prism, and it was part of the demonstration at Potsdam that they were not sensibly refracted in passing through water. This might reasonably be expected to be the case if, as was suggested last week, the new radiations are really undulations of very long period, but a statement that they also pass through thin aluminium plates is not so easily explicable. Prof. Röntgen himself has not yet advanced any theory on the subject. At the conclusion of the Potsdam experiments the German Emperor invited Prof. Röntgen to supper, and remained with him and other guests conversing about the invention till midnight, when he personally handed Prof. Röntgen the Crown Order, Second Class.

Direct Production of Electricity.—Dr. Louis Duncan, writing in *Cassier's Magazine* on the subject of the direct production of electrical energy, remarks that, in the words of Prof. Borchers, "the problem is the conversion of the energy of fuel (including fuel gases) into electrical energy by oxidation without transforming the energy into heat, and without the destruction of the chemical reagents or the formation of waste products that require regeneration." After dismissing thermo-electric couples and gas batteries as offering no prospect of a practical solution, Dr. Duncan says that for the use of solid fuel in the place of gases many plans have been tried, and a number of patents taken out. It is often stated that some inventor has solved the problem, but such announcements are never followed by performance. "It is not so very difficult to oxidise the carbon. There are a number of batteries which do this, but the oxygen is usually taken, not from the air, but from the electrolyte." It is then urged that if the problem is solved with a solid fuel, the solution will be a simple one. It really means the discovery of a proper electrolyte. Of course, the carbon must be put in the form of a conducting mass, but this can be done for a small sum. Dr. Duncan then continues, "I have experimented upon a number of patented methods, but up to the present time I know of no method that has been publicly described that fulfils the conditions or gives any promise of success. But I have seen a method not patented yet, and, unfortunately, not mine, which does apparently fulfil the conditions, and which gives currents, not measured milliamperes, as is ordinarily the case, but in honest amperes, and plenty of them." The rest of the article deals with what will be the consequences of the solution of the problem, but until we hear what Dr. Duncan's solution is these may be left over.

Gas-Engines.—At a meeting of the Institution of Junior Engineers last week, Mr. H. J. Young in the chair, a lecture on "Problems Connected with the Theory, Working, and Testing of Gas-Engines and Hot-Air Motors" was delivered by Prof. T. Hudson Beare, B.Sc., M.I.C.E. The lecturer began by giving a short account of the early forms of hot-air motors, describing the Cayley, Stirling, and Ericsson motors as representatives of the three classes into which he divided these engines. He gave a *résumé* of the long discussions at the Institution of Civil Engineers on the value of the regenerator, which led to a paper by Sir Wm. (then Mr.) Siemens, entitled "The Conversion of Heat into Mechanical Effect." This was the first time the then novel mechanical theory of heat had been brought before engineers, and a short description of the early gas engines—Lenoir, Otto, and Langen, and other forms—was then given. Dealing next with the possible cycles which can be adopted for hot-air motors, the lecturer gave first a brief summary of the general principles of all heat motors. For each type certain temperature limits had been chosen, and the maximum possible efficiencies and the actual possible efficiencies of each were worked out and shown in a table exhibited to the meeting. The cards for each cycle had also been prepared, and diagrams illustrating an engine of each class, the table and diagrams showing very clearly the large amount of power absorbed by the pumps in most of these engines, to which circumstance was due their low mechanical efficiency. It was also pointed out how poor the average effective mean pressure obtainable was. The actual efficiencies reached in practice were given, and the reasons, both thermodynamical and practical, why these motors failed so to reach their possible efficiencies were discussed. Prof. Beare then proceeded to consider the gas-engine. After indicating the advantages of the De Rochas cycle, he contrasted the small amount of work spent in the pumping stroke in the gas-engine as compared with the large amount it became in hot-air motors. The question of the value of a regenerator in a gas-engine was investigated, and the points illustrated by two fully worked out examples; it was shown that the possible efficiency could be increased by its use, but probably at the expense of making the engine bulkier for a given power by reducing its effective mean pressure during the working stroke. The testing of gas-engines was lastly dealt with, all the observations needed being fully treated; the difficulties in carrying them out, and

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the best means for ensuring accuracy of results, were mentioned. The lecturer explained how it was possible to work out a complete heat balance for any gas-engine without directly measuring either the quantity of air used or the temperature of the exhaust. It was necessary to assume the temperature of the charge just when compression was about to begin, and it was shown that this must be about that of the jacket-water. This was the only assumption to be made. A discussion followed.

Electrolytic Zinc and Lead. — An article by R. Lorenz in *Zeitschrift für Anorganische Chemie* is summarised in the *Journal* of the Chemical Society. The chief difficulty to be overcome in the electrolysis of zinc chloride is to obtain the salt entirely free from water. The zinc chloride, which still contains water, is placed in a V-tube of combustion glass and heated to quiet fusion. A carbon electrode is placed in each arm of the tube. Directly the current is started a brisk evolution of gas, due to the presence of water, takes place at both electrodes. The gas evolved at the positive electrode is at the commencement hydrogen chloride, but after some time chlorine is evolved. Meanwhile, the evolution of gas at the negative electrode diminishes, and zinc begins to be deposited. During the deposition of the first few drops of metal a brisk evolution of hydrogen takes place at the negative electrode. As the zinc which is deposited at first is not pure, but contains lead and other metals which may be present, the molten electrolyte is poured off into a similar V-tube as soon as the less positive metals have been deposited, and the electrolysis is continued. Pure zinc is then deposited. The electrolyte, which now consists of pure zinc chloride, is a clear, limpid, highly refractive liquid, under which the molten zinc appears like mercury. It solidifies, on cooling, to a white, porcelain-like mass, and is the most hygroscopic substance the author has worked with. Fused lead chloride is easily electrolysed in a similar way. Fused cadmium chloride is not so easily electrolysed; chlorine is at once evolved at the anode, and at the cathode brownish-black clouds which dissolve in the electrolyte, whilst a small quantity of cadmium is deposited. The electrolyte contains a lower chloride of cadmium, which can be obtained as a crystalline metallic powder by lixiviating the electrolyte with water; this compound is difficult to dissolve in hydrochloric acid, and the solution does not at first give a precipitate with hydrogen sulphide, but, after some time, a yellow precipitate is suddenly deposited. In the electrolysis of fused silver chloride, the silver is deposited as a brown mass, and when a small quantity of melted zinc or lead is placed in contact with the cathode, the silver dissolves in the molten metal. Silver chloride dissolves in zinc and lead chlorides, and, on subjecting the mixture to electrolysis, the silver is deposited first. The silver is also deposited when a zinc rod is placed in molten zinc chloride containing silver chloride. Copper chloride, dissolved in zinc chloride, in which, however, it is only slightly soluble, can be electrolysed by employing a cathode of molten zinc, when all the copper is obtained as a zinc-copper alloy. Mixtures of zinc, silver, lead, copper, and cadmium chlorides on fusion give colourless electrolytes, which are easily manipulated. The addition of lead chloride to zinc chloride greatly increases the ease with which the fused salt is dehydrated by heat alone, and magnesium and calcium chloride produce the same effect. When such mixtures of fused metallic chlorides are electrolysed, the metals are deposited one after the other, and can be obtained pure by fractional electrolysis. As the result of these experiments the author has worked out a practical method which he suggests might be adopted for winning zinc and lead from their ores by electrolysis.

Electricity in Medicine.—Dr. W. S. Hedley, the medical official in charge of the electro-therapeutic department of the London Hospital, has communicated an important article to the *Lancet* on the use of "Current from the Main' in medical practice. With reference to the use of dynamo currents, he remarks that "although the current produced by the E.M.F. of the continuous-current dynamo is unbroken and always flowing in one direction, it cannot be said to be absolutely uniform in strength. That is to say, the current obtained, for example, from a single dynamo having a commutator of only a few sections is undoubtedly a 'pulsatory' current. But such are not the conditions that exist in dealing with continuous currents from modern central lighting stations. In the latter case a number of dynamos, usually running at different speeds, and having commutators of numerous sections, are used in parallel with accumulators of large capacity. The current emanating from such a source cannot be called pulsatory. Its line of E.M.F. with the now universal constant-potential system may be regarded as practically straight." Comparing, however, the effects produced by a continuous lighting current of 100 volts, reduced by a resistance in series with the patient with those produced by a Leclanché battery of just sufficient voltage to give the required number of milliamperes, Dr. Hedley remarks that: "It is noticeable that with a dynamo current used through a resistance in series with the patient greater pain accompanies, and a greater skin-reddening follows, the application than when a continuous-current battery is used, and that both effects are decreased by pressing upon the electrode—in other words, by making a better electrical contact. In looking for an explanation of this it is to be remembered that an imperfect contact may have a high E.M.F. across it, and that the heat generated in any circuit or part of a circuit is in proportion to the watts absorbed. This may give rise to considerable local heating. With high-potential currents the available E.M.F. is greater, therefore the possible heating effect may be comparatively great. The importance of a good contact—well warmed, well wetted, and carefully adjusted electrodes—is known to all who use such currents on the living body, especially with imperfect apparatus." If, however, these effects are foreseen and understood they can be obviated. Passing to alternating currents, Dr. Hedley says that a lighting current differs from a true sinusoidal current "chiefly in the comparative irregularity of its curves, an irregularity depending upon the construction of the dynamo, the capacity, and self-induction of the circuit, and other causes. The faradaic current differs from both the foregoing in the fact that its positive and negative maxima are very suddenly attained and are unequal in extent; the current is therefore a dissymmetrical one. From these physical differences arises a dissimilarity in physiological effects. Inasmuch as the excitant action of an electrical current bears a direct ratio to the suddenness of the fall of potential, it follows that the sinusoidal current will be better tolerated than the more brusque alternations of the coil. Also on this account it is equally evident that the latter for certain purposes can never be altogether supplanted by the currents of smoother curves. On the other hand, where effects on general nutrition, rather than on muscular contraction are sought, the latter currents present decided advantages. It has been shown by d'Arsonval that in a person subjected to alternating currents of a sinusoidal character, although the current be scarcely felt and excite no muscular contraction, the nutritive exchanges undergo an augmentation of from 40 to 50 per cent., the 'respiratory capacity' being almost doubled." These effects are probably owing

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to an influence on nutrition due to the decompositions and recompositions that must ensue on the passage of an alternating current through the tissues. The alternating currents of commerce, partaking as they do of the sinusoidal character, present a means of increasing the nutritive exchanges by a direct action in virtue of their sinusoidal type, and by an indirect action in virtue of the muscular contractions they induce. Applied chiefly through the medium of the water bath, this alternating lighting current is daily employed in practice, and seems to act as a general tonic, and to stimulate the nutritive exchanges. Its employment has been followed by good results in chloro-anæmia, rickets, muscular atrophies of myopathic origin, obesity, gout, sciatica, and rheumatism, the latter in its articular as well as in its muscular manifestations. This current is easily handled for medical purposes, and its use is now by no means uncommon." After describing, with illustrations, apparatus for varying and controlling the voltage and current, it is remarked that "the time ought to be approaching when electricity will be prescribed and administered not only in measured units of intensity, density, and time, but with definite ideas of the shape of the E.M.F. curve and of the therapeutic indications that a given curve may be expected to fulfil." The article is followed by a note on the safeguards that may become necessary when, under the revised regulations of the Board of Trade, currents of considerably higher voltage than are now common come into use.

Worthless Electric Lamps.—"It is my experience," writes a correspondent to the *Daily News*, "that incandescent electric lamps are no longer what they were. They last, as a rule, such a very short time that I am tempted to give up electric lighting altogether and fall back upon gas as being more economical and less annoying, though not so healthy. Can nothing be done to remedy the deterioration which seems to date to the period when lamps became suddenly very cheap, owing, as I believe, to the expiration of the patents?" Special enquiry in well-informed quarters has shown that the above complaint is well justified, but that it cannot apply to the best class of lamps made in England. Mr. W. H. Preece, the electrician and engineer-in-chief to the Post Office, has made a close study of the whole subject. The installation at the Post Office in St. Martin's-le-Grand comprises 10,000 lamps, and the whole number under Mr. Preece's direction exceeds 50,000. He has, therefore, been able to institute photometrical tests of a most elaborate and exhaustive character, and the records of these tests have furnished a mass of data which are in course of arrangement in order that they may be presented to the world in a practical form. Mr. Preece will shortly enable the users of electric lamps to determine in the course of an hour the probable longevity of any lamp. At present no such guide is available to the public, and one consequence has been that cheap electric incandescent lamps, such as are ordinarily bought in a shop, are frequently so faulty in construction that they are speedily used up, and electric lighting falls into discredit because of the cost entailed by constant lamp renewal. The evil which domestic consumers are experiencing here is set down, principally, to German competition. Lamps are, it is true, to be bought for one-tenth of the price paid for them 12 years ago, but they are often not worth the money that is now asked. There is danger, it is said, that further deterioration may take place unless something be done to protect the consumer. In Germany a committee has been appointed to enquire into the reasons for the sad falling off in quality and to find out a way to compel makers to supply good lamps. The recommendations of this body of experts will, it is probable, lead in Germany to the standardising of incandescent lamps, and it is predicted that all the rejected ones will be thrown upon the English market. At the General Post Office no lamp is used that is not of the best English make, and a preliminary test is employed. The household consumer has, however, no means of protecting himself. Mr. Preece says that it is not uncommon for cheap German lamps to be marked as of 100 voltage, when the true voltage is 98. This misstatement, too, it appears, is not due to mere carelessness on the part of the maker, but is an intentional deception; for when a 98-volt lamp is provided with a 100-volt current it is quite evident that it will glow more brightly for a time, its increased brilliancy, however, being obtained at the cost of its shortened "life." To employ a simile, the lamp starts with a balance of, say, 1,000 hours to the good, and it overdraws its account every day, so that its spendthrift existence comes prematurely to an end. Theoretical perfection implies that the voltage—the pressure applied to the electric main and to the lamp—should be equal and constant; but though it ought not to be difficult to ensure that the lamp and the current should be judiciously mated and uniform, the degree of the pressure in main and lamp alike must vary according to circumstances, depending as it does upon the speed of the engine and, in some degree, upon the rate of consumption. Inequality of pressure, however, is less dangerous to the life of a lamp than the attempt which is made by some people, desirous of obtaining a brighter light, to use a lamp of lower voltage than heretofore, and to force through it an unreduced current. When this is done with a cheap German lamp, wherein the operation has been already discounted, the probable lifetime is correspondingly reduced, and the lamp which is supposed to live 1,000 hours does not last for as many minutes. But how is the consumer to forearm himself against the twin risks—that of inequality of pressure and that of too high a pressure? The first he cannot wholly avoid; as to the second risk, at present there appears to be no safeguard against loss except that of buying the best English lamps in the market at, perhaps, double the cost of the cheapest German article. Since lamps of higher efficiency have been introduced as being more economical, the term of their life has been reduced from 1,000 hours to about 800 hours, or under, for a three to three and a-half watt lamp. It is argued that one may have a lamp too long in use. After a while a deposit of soot obscures the inner side of the vacuum globe, which, of course, cannot be cleaned, and the filament itself loses its incandescent power. On that theory people are recommended to renew their lamps more frequently than they do, and not to wait until the lamp gives out completely. The difficulty is to tell when the moment arrives for the economical replacing of the globe, and before this can be determined one must know for how long the lamp should be retained. Mr. Preece's test will be, it is understood, at the disposal of such a body as the St. Pancras Vestry, whose installation was the first of the kind in London. But under the existing system the test could not be employed in St. Pancras, the local authorities having no concern in the supply of the lamps, contenting themselves with producing the current and distributing it to the consumers. There seems to be an idea that if a vestry undertook to "wire" houses, and to sell the proper fittings, a public outcry would be raised against monopoly. Yet, in Mr. Preece's view, the lamps should be furnished by the producers of the current—the one being in intimate relationship with the other.

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ELECTRIC RAILWAY PRACTICE IN THE UNITED STATES.*

In the bustle and confusion of a rapidly growing industry, when inventions, new discoveries, and applications follow close upon the heels of others only recently in good repute, when all is strife, eagerness, and emulation, men do not stop to ask themselves, "What have we accomplished?" or "Whither we are drifting?" They say instead, "This one step must be taken or our rivals win." So it has been, and even yet is, in electric railroading. Few things are perfect, few things can be called standard. In spite of all that has been done in these last 10 years, in spite of the fact that within the last five years not less than 1,500,000 h.p. of electrical machinery has been manufactured for railway purposes, the field is broadening with every day's new life, and few can assume to understand how far we shall have to go before we exhaust the infinite applications in the science of transportation where electricity is to find its mission. Yet it is well in the midst of a busy life to pause occasionally and to get a measure of what has been done, and to determine, as far as our wisdom will permit, in what direction our next efforts should be turned for the greatest individual and general profit. It is with the hope of taking some such general survey of the field of electric railroading in the United States that this article is written. An attempt will be made to sift out from the mass of conflicting practice to be found in the United States that which is modern and approved from that which is past and obsolete.

The Overhead Wire System.—The overhead wire system is the only one which has proved entirely adequate and satisfactory in the varying conditions found in American cities—such as the severe storms of the North, the dry and gritty sands and salt, moist breezes of the Gulf States. The road-bed construction is, up to the present, in a state of transition, but the old horse railway track, with its flat side-bearing rails spiked to longitudinal stringers, has gone by for ever. The use of concrete as a substructure for track construction is not as general in America as abroad, although in the principal cities of Canada and a few in the United States it has been used with excellent results, giving much greater solidity and permanency to the track than where the foundation is the natural dirt, gravel, or clay. Wooden ties are reasonably plentiful and cheap in the United States, and are generally used instead of metal ties, which, however, have been recently adopted in Detroit, Terre Haute, and a few other cities, chiefly in the West. The ties are usually placed close together, rarely exceeding 2ft. or 2½ft. centres. Creosote and other preservative compounds are rarely used, it being the general opinion that the life of the tie will be at least as long as that of the rail, but not of double that period, so that in relaying a road bed it would not be advisable to put new rails on old ties, even if the latter were in fairly good condition. Our illustrations show some typical road sections, which may be taken to fairly represent the present practice.

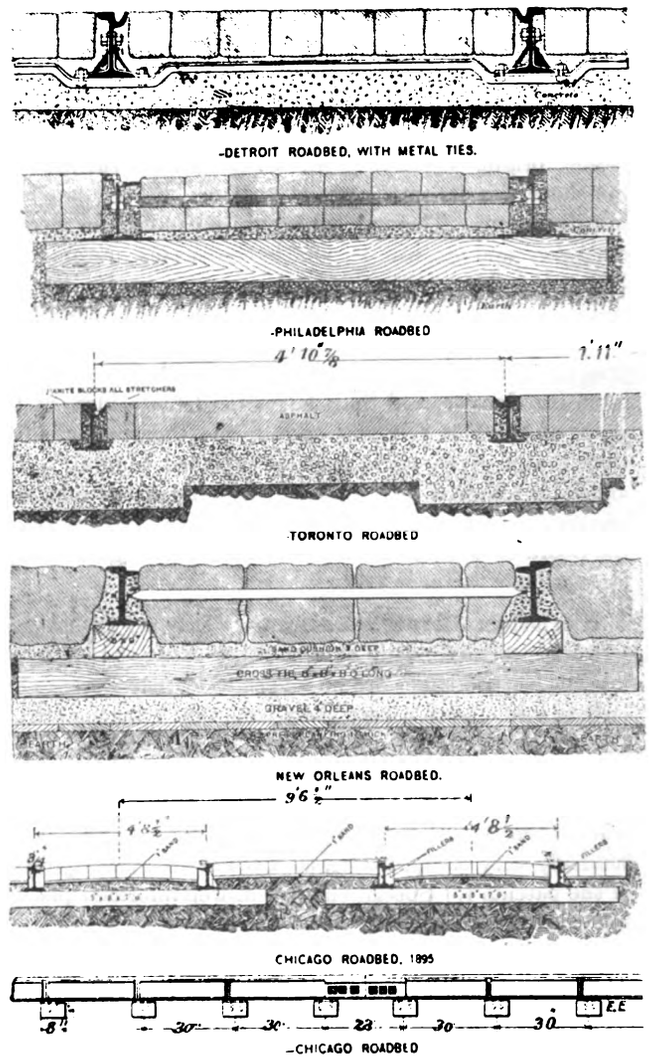
Rail Sections.—Only two or three years ago rails 6in. and 7in. deep, weight 60lb. to 70lb. to the yard, were considered heavy, and were the accepted practice even in the larger cities. These rails were generally mounted on chairs, in order to reach the ties placed just underneath the paving blocks. To-day, however, the chair construction is entirely abandoned. Now, rails from 8½in. to 9in. deep are preferred, and are spiked direct to the ties. The weight of these deep girder rails is now from 85lb. to 95lb. per yard. The best practice as regards joints now is to lay the rails close together, allowing no space whatever for expansion and contraction. The theory is that the rail is so thoroughly protected by the pavement against changes of temperature so that there is very little necessity for making such an allowance. Occasionally, however, a small space is left between rails every 250ft. or 500ft. A great deal of wear at the joints has been obviated by thus butting the rail firmly together. Apart from this, however, the joints have been strengthened by the more general adoption of longer joint plates. Eight and twelve bolt joints, from 28in. to 36in. in length, are the best practice. Riveted and welded joints are also being tried.

Overhead Construction.—The general principles on which the best overhead material is made and the entire structure is erected are the following:

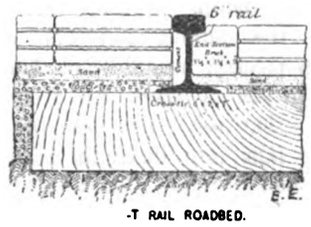
1. All hangers, switches, and other appliances connected with the trolley wire are supported by the span wires as near as possible at the line of the trolley wire. Originally, this support was several inches above the wire.

2. The bending or kinking of the trolley wire in appliances is avoided, together with any method of support which tends to put sharp and sudden bends in the wire in service.

3. The strains from service are taken by the metal parts of the appliances, not by the insulation.



Examples of Typical Roadbeds.



4. Frogs, cross-overs, circuit breakers, etc., are so constructed that the trolley runs over them smoothly, without being obliged to dip and return to wire, as was the case with some of the earlier appliances.

5. The materials used are strong and serviceable, the metal being usually of bronze, or, in the cheaper appliances, malleable iron, while insulation has been made which combines excellent insulating qualities with great resistance to breakage in any direction, or by sudden blows such as sometimes come from the trolley.

* Condensed from the *Street Railway Journal.*

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6. The wires are so put up as to have several insulating points between trolley wire and ground, the first being usually the trolley-wire hanger itself, the second one or more strain insulators in the span wires, and the third the insulation of the pole tops by a wooden plug from the lower portions of the poles.

7. The curve construction is much less objectionable than was originally the case, owing to a better understanding of the different problems involved.

8. Almost all street railway systems of any size are sectionalised, so that trouble with the overhead system on one section will not interfere with the operation of cars upon all the others. The feeders leading to these sections are provided with fuses or circuit breakers at the station, so that a falling trolley wire will instantly break the circuit, and the wires from that section will become "dead" until the arrival of the emergency wagon. Moreover, in case of fire it is possible for the firemen to tear down the overhead structure and handle the wires thereafter without fear of shocks. This system of putting up the wires has done away with some of the most serious objections originally urged against the overhead electric system.

Generating Plant. – The tendency of the last few years has been towards direct-coupled plant and large units. In the early days, shafting, belts, and counter-shafting were everywhere employed. Now, although some belt-driven plants are still being manufactured, the bulk of the new sets are direct coupled. The table given on page 66 shows the practice of one of the large engine manufacturers in the matter of weights, speeds, diameter, weight of flywheels, etc.:

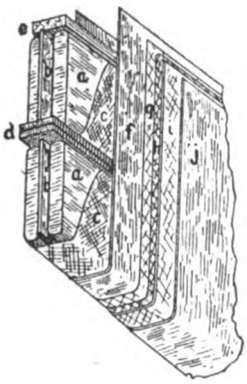

FIG. 1.—Arrangement of Conductors in Slot. *a* Conductor. *b* Fuller-board strip between conductors. *c* Linen tape. *d* Composite strip between top and bottom conductors. *e* Hardwood strip closing top of slot. *f* Fuller-board trough. *g* Trough of oiled paper. *h* Trough of mica. *i* Trough of oiled linen. *j* Fuller-board trough.

Referring to these large generators, the Walker Manufacturing Company, of Cleveland, O., have recently put upon the market an 800-kilowatt machine, of which some views are presented herewith. Two of these generators have been installed in the power station of the Detroit Railway Company, of Detroit, Mich. They are similar in design to the generators of the 400-kilowatt size built by the same company, so that a general description of the 800-kilowatt size will be typical of the other standard Walker Company's generators.

The magnet yoke is 13ft. 9in. in diameter by 28½in. wide, and is of cast iron. This material is considered by the makers to be superior to steel for this purpose, since, on account of the greater section required (the section being more than twice that of a steel yoke), a very much greater rigidity is obtained. The poles are 12 in number and are of soft iron, laminated and cast into the yoke. They have pole shoes of cast steel, which serve also to keep the magnet spools in position. The yoke ring rests upon broad feet at each side securely bolted to heavy cast-iron girder plates. These girders are extended to such distance that the yoke may be slid along in a direction parallel to the shaft sufficiently to be entirely clear of the armature, thus allowing complete accessibility to either the magnet coils or armature. The girders are laid in concrete and cement upon massive capstones, and are secured by heavy bolts passing down through the foundation.

The armatures are of the iron-clad type, 8ft. 10in. in diameter by 37in. in length, exclusive of commutator. Together with the commutator, it occupies a length of 45in. on the shaft. The plates are punched in segments from soft, well-annealed iron, and are secured by dovetailed projections fitted into corresponding slots milled in the rim of the spider. This detail is illustrated in the engravings, Figs. 3 to 6. The plates are held longitudinally by heavy end rings, the fastening bolts passing just inside of the laminated core. These end rings also serve as supports for the portion of the armature winding outside of the slots. An important detail of construction is shown in the engraving of the armature spider. It will be noticed that the rim of the spider is not made solid, but that the arms end in a sort of T-head. This is done to eliminate all danger of shrinkage strains, and it will be obvious to any engineer that this is a very simple and effective method of accomplishing the desired result. It is claimed to be superior to the old method of splitting the hub, and, furthermore, gives a better chance for more thorough ventilation of the armature core. The commutator spider is mounted upon a projection of the armature hub, and securely keyed thereto. The laminated core is divided into a number of sections separated by ½in. air-spaces, allowing an ample circulation of air.

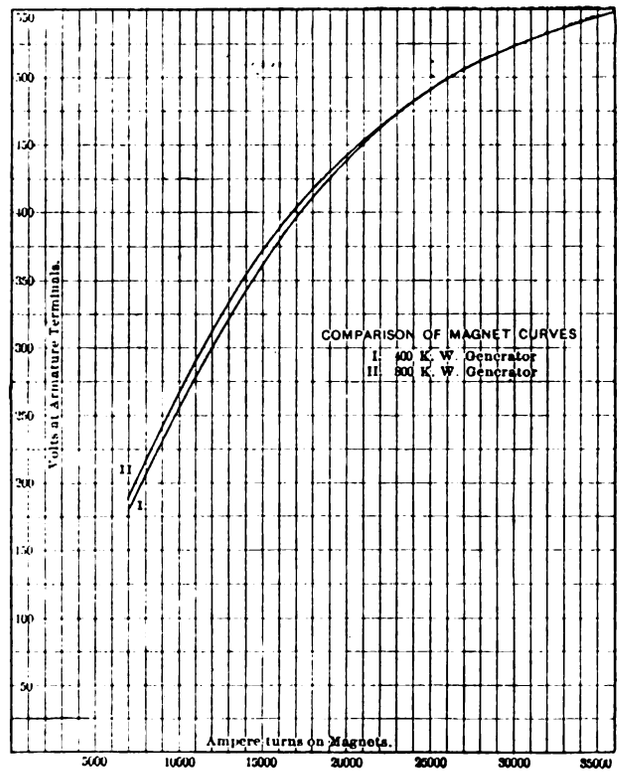

FIG. 2.—Characteristic Curves of the Large Dynamos.

The armature winding consists of flat copper ribbon formed into proper shape before being attached, and is entirely without joint except at the commutator leads. The coils are very thoroughly insulated in the manner illustrated in Fig. 1, and are held in place by phosphor-bronze bands.*

The construction of the commutator is shown in section in Fig. 5. The bars are held in place by a sectional clamp, so designed as to draw the bars firmly down on to the flat cylindrical surface of the spider. The leads are both riveted and soldered to the bars, and are made long and flexible. The diameter is 84in., and the active wearing face is 11in. The current density in the carbon brushes at full load is a little less than 35 amperes per square inch.

* As will be gathered from the description and the sectional view, the method of winding the armature is that of having two conductors in each slot, one abeve the other. The end connections can then be made of the cylinder type invented by Mr. C. E. L. Brown, of Baden, as described in our issue for August 16, 1895. In the above armature, however, the conductors are bent from one plane into the other at the engine end of the armature, and hence soldered joints only occur at the commutator. As seen in Fig. 1, each conductor consists of two parallel strips of copper.—ED. *E. E.*

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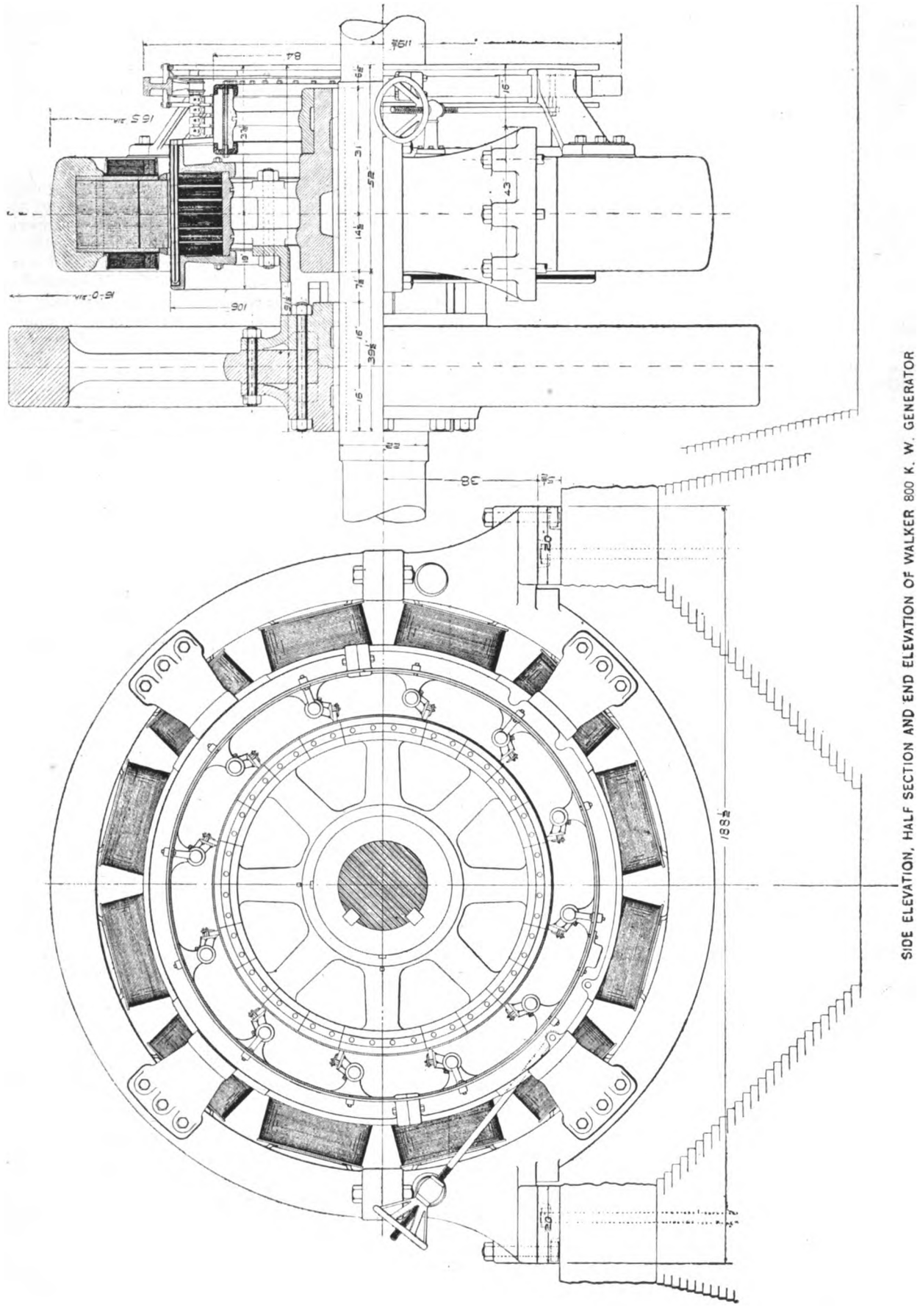
The shaft is of forged steel, 22in. in diameter in the armature hub, and 19⅞in. in bearings.

The brush-holders are novel in design, in that the carbon is clamped solidly in the holder, giving the current a low-resistance path from brush to stud with no sliding contacts. The brush has a parallel movement, so that there is no rocking motion of the carbon when the commutator is slightly out of truth.

The general dimensions of the 400-kilowatt machine are as follow: outside diameter of yoke, 12ft. 2in.; diameter of armature, 90in.; diameter of commutator, 70in.; face of commutator, 8½in.



SIDE ELEVATION, HALF SECTION AND END ELEVATION OF WALKER 800 K. W. GENERATOR

FIGS. 3 AND 4.

It has been the aim of the manufacturers to produce a generator which should fulfil the exacting requirements of railway service with ease. Particular attention has been given to the details of mechanical design, and

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the illustrations given of some of these details are intended to show how this has been effectively accomplished. These generators were designed for a constant voltage in the station of 550, and to divide the load as nearly as possible proportionally. The results have been gratifying to the manufacturers in all respects. The maximum variation of voltage at the switchboard is actually less than 2 per cent. under all variations of load. An inspection of the curves shown in Fig. 2 will show how perfectly the magnet characteristics of the two machines are matched, ensuring an almost absolute proportional division of the load between the various machines in operation.

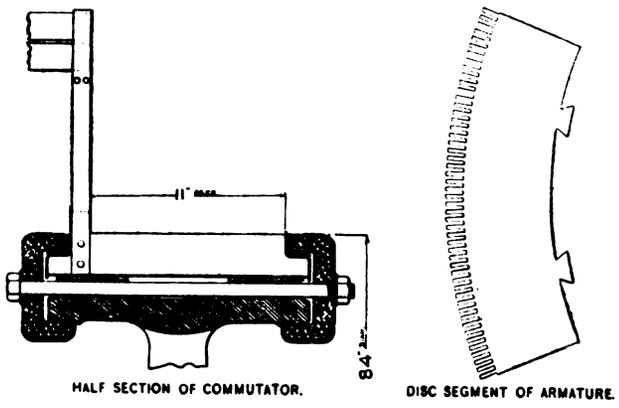

FIG. 5.

The full-load ampere rating of these generators is 730 amperes for the 400-kilowatt, and 1,460 amperes for the 800-kilowatt. With a continuous full load the temperature increase of the 400-kilowatt machine is 76deg. in the magnet coils and 73deg. in the armature. The increase of temperature in the 800-kilowatt generator is approximately the same under similar conditions.

A special study has been made of the question of non-sparking operation, and it has been the aim to so design these generators that without any brush shifting the non-sparking limit will be between 50 and 75 per cent. overload.

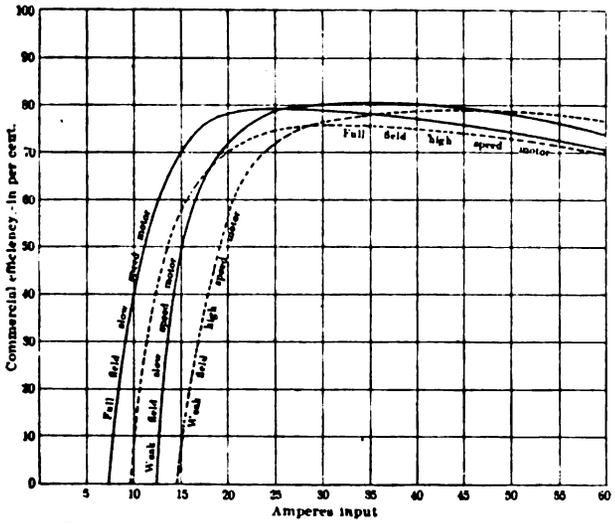

FIG. 7.—Efficiency Curves of a Street Railway Motor.

The practical operation of the generators has given results that are all that could be anticipated. As an illustration, it was necessary recently when two 400-kilowatt machines and one of the 800-kilowatt were carrying the load to shut down for a short time the 800, throwing the whole load, which happened to be 3,000 amperes, on to the two 400-kilowatt generators. They carried this overload of 100 per cent. for the time required without the least difficulty, and with only a slight sign of sparking, there being no shifting of the brushes. This illustration is given merely as an example of what these generators are able to stand up to in case of emergency. The commutators have taken on a dark, glossy surface, and in the case of the first generator installed the commutator has been running for about 60 days at the present writing without having been once dressed down with sandpaper. The others are behaving in the same manner.

The author then proceeds to describe most fully the modern street cars and motor trucks. The adjoining curves (Figs. 7 and 8), taken from a typical motor, are worthy of note. It will be seen that, although the efficiency curves hardly rise about 80 per cent., they are fairly flat for all loads about one-third of the maximum. The author, after reviewing the present state of conduit systems and cars carrying storage batteries, draws the following general conclusions in answer to the query, Will the overhead electric railway system ever be superseded by another and better system?:

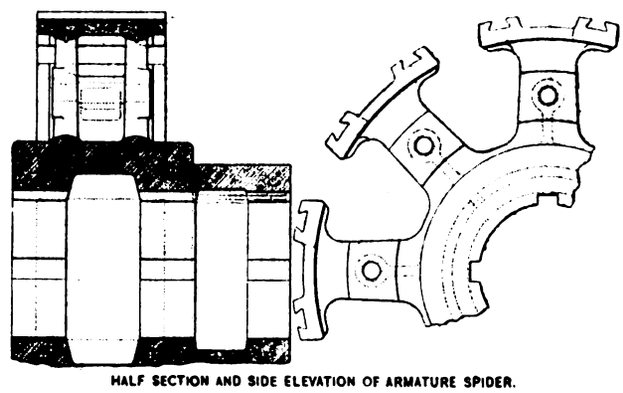

FIG. 6.

The ideal system is, of course, a self-propelled car carrying its own motive power, but compressed air, gas, ammonia, and steam have so far proved inadequate in power, or in other respects not adapted for street railway use, and almost nothing is, to-day, being done in that direction. One great difficulty in any system of this kind is that of providing sufficient motive power to always return a car to its source of supply, and in the complicated conditions of city street traffic a blockade is a serious affair indeed. Nevertheless, new applications of nature's forces, or new materials to work with, are constantly being brought out, and while it is extremely improbable that some entirely new form of motive power will be found

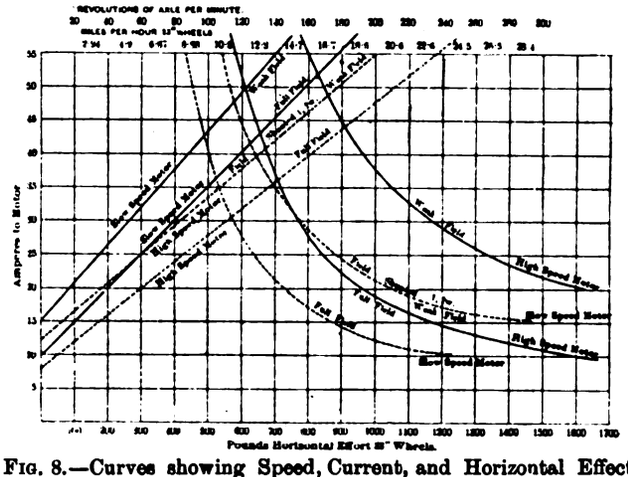

FIG. 8.—Curves showing Speed, Current, and Horizontal Effects of a Street Railway Motor.

peculiarly adapted to street-car propulsion, it cannot be said to be impossible.

The electric system, both overhead and underground, possesses certain intrinsic advantages which seem to make it in some respects the ideal system for street railroading. The first of these is found in the remarkable cheapness with which the motive power can be generated. In some of our large stations the entire cost of motive power for even a long double-truck car has been brought down to 6·25d. per car mile, and, under favourable conditions, to even 5d. per mile, this cost covering coal, water, station labour, lubricants, and repairs, and depreciation of station plant.

The motors are to-day far more efficient and mechanically perfect than formerly, as will be seen by the curves, and

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TABLE SHOWING PRINCIPAL CHARACTERISTICS OF DIRECT-CONNECTED ENGINE GENERATORS.

Dynamo capacity.	Engine capacity.	Boiler pressure.	Speed.	Engines.					Weight per H.P.	H.P. per sq. ft.	Dynamos.					
				Cylinder.		Weight.		Floor space.	Weight per sq. ft.		No. of poles	Weight.		Floor space.	Weight per sq. ft.	Weight per E.H.P.	E. H.P. per sq ft.
				Diameters.	Stroke	Engine (total).	Fly-wheel.					Total.	Armature.				
Kw.	H.P.	Lbs.	R. P.M.	In.	In.	Lbs.	Lbs.	Sq. ft.	Lbs.			Lbs.	Lbs.	Sq. ft.			
225	255	125	120	14·26	36	90,000	25,000	485	186	353	·526	6	37,000	14,520	54	685	123	5·55
300	340	125	100	16·30	42	120,000	30,000	520	231	353	·654	6	60,400	20,720	78	774	151	5·13
400	455	125	100	18·34	42	135,000	40,000	546	247	297	·833	8	71,440	30,580	90	794	134	5·92
400	455	125	80	20·38	42	150,000	50,000	600	250	329	·758	8	74,250	31,480	96	773	139	5·55
500	567	125	75	20·38	48	180,000	60,000	640	281	317	·886	10	87,150	35,800	95	917	131	7·01
800	907	125	80	26·50	48	240,000	85,000	910	264	265	·997	10	110,000	49,440	115	956	103	9·27
1500	1800	140	75	32·62	60	450,000	150,000	1,386	325	250	1·299	12	163,200	73,100	144	1,133	82	13·90

it is doubtful if any materially greater efficiency can be obtained for a class of service which calls for such widely fluctuating amounts of power.

Altogether, therefore, the electric distribution for street railroads, considered from economic grounds, is not likely to be improved upon within its own lines of development, and the question then becomes, What particular method of distribution is to be final or best adapted to the purpose—the overhead system, the underground open or closed conduit system, or some other system yet to be devised?

This question can only be answered in a longer experience with both kinds of conduit work than is at present at our service. The overhead electric system has been tested under all conceivable circumstances, and has in every case proved itself adequate to the burdens placed upon it. It handles the heavy traffic of our principal city streets, it carries our people to their suburban homes, it pushes its way out into the country and increases land values, and in joining cities and towns on lines 20 or 30 miles in length it has proved so much more popular than parallel steam railroad lines as to seriously alarm railroad magnates and to cause their violent opposition to the spread of electric railroading.

COMMUTATORLESS DYNAMOS.

BY JAMES WHITCHER, A.I.E.E.

The *Journal* of the Institution of Electrical Engineers, May, 1895, gives an abstract of an article by Riccardo Malagoli in vol. i., 1895, of *L'Eclairage Electrique* on "An Alternating Rotary Magnetic Field and its Application."

There are statements in this abstract which call for criticism, but before discussing them the writer would say that he has not had an opportunity of referring to the original article, but he has no doubt that the abstracting has been as carefully and conscientiously done as usual.

The article deals geometrically with a subject of considerable interest in the theory of alternating currents, but there is certainly something wrong about the result. It is just as impossible to make a commutatorless direct-current dynamo in the way he suggests as in any other bar the one—the so-called unipolar method. The writer has reason to be positive about this, for he has put it to the test. About two years ago he became entangled in much the same line of thought, and he did not get clear of it again until practical experiment demonstrated conclusively to him the utter futility, not to say nonsense, of the idea.

It will bring the subject down from the clouds of vague theory and give it more practical interest to describe this experiment, but, in the first place, it is advisable to follow out the line of reasoning which seems to call for and justify the experiment. To keep a good practical colour on the discussion we will discard the idea of rotating vectors, and treat it only with reference to the "concretest" of electrical notions and apparatus. Thus, consider the piece of electromagnetic mechanism sketched in Fig. 1. It is a stationary Gramme ring, A, wound with a continuous circuit, having connections, B and C, brought out at opposite points on a diameter of the ring. Within the ring revolves the field magnet, D, with poles as marked. It is evident that the rotation of D will produce an alternating E.M.F. at the terminals, B and C, and that the characteristic curve of this E.M.F. will depend upon the arc covered by the pole-pieces of D. In the case shown the polar arcs are 120deg. each, and the curve will be like A in Fig. 2. This is the effect of a constant bipolar magnetic field rotating within a bipolar Gramme ring. Now, if the revolving magnet, D, be excited with an alternating current, the magnetic field will also alternate as it rotates.

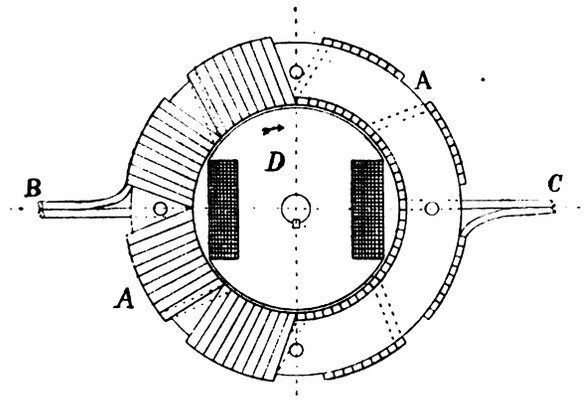

FIG. 1.

The effect this alternating rotary field will have on the windings of the stationary ring is very complex and difficult to analyse in a general way. But assuming that the period of the exciting current is equal to that of the revolution of the field magnet, and that the field is at its zero values when the polar axis is on the diameter, B C, the case is much simpler. It happens, then, that the rotating field is always of one sign on one half of the ring, and the opposite sign on the other.

Probably more often than any other has this circumstance been seized on, in some guise or other, as a fancied solution of the commutatorless-dynamo problem. At first sight it does look as though the current in the ring windings must at least be unidirectional, though it may be pulsational. However, it is not so. Analysed by means of the calculus, it is quickly seen that the actual effect is to produce an alternating current of double the frequency of the exciting current. It is not easy to work it out otherwise; but remembering that the alternating field has what may be called a "transformer" action as well as a "dynamo" action on the ring windings, we can approach this result nearly enough to realise its truth. For following out the "transformer" action alone, it is seen that it will give two maximum values of E.M.F. per revolution both of the same sign, and occurring when the polar axis is on the diameter B C; and the "dynamo" action is seen to give also two maxima of like sign, but opposite to the two former, and occurring when the polar axis is at right angles to B C; and the zero values of either action concur with the maximum values of the other: hence the E.M.F. will alternate twice per revolution of the field, and its curve may be

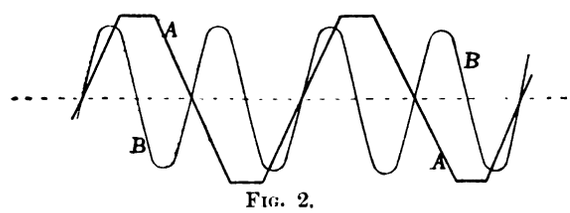

FIG. 2.

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represented by B of Fig. 2. If all the variables involved were simple sine values, this curve would be a symmetrical sine curve also.

From the foregoing it is clear that a *bipolar* alternating rotary magnetic field applied to a stationary bipolar Gramme ring will not produce a continuous current. However, it is not a bipolar field that is actually understood in this paper of R. Malagoli's, but rather a multipolar field, or equivalent to one having an infinite number of poles. It is necessary, therefore, to pursue the investigation further, what has preceded being a helpful preliminary. If the rotating magnet be as nearly as possible a complete drum of laminated iron with quadripolar winding, as in Fig. 3, and the adjacent poles be excited with alternating currents of 90deg. difference in phase, while the drum rotates once per period of alternation, the field produced will be a near equivalent of the one of infinite poles required. The resultant effect of the two-phased exciting currents is to produce poles of the given maximum strength successively on every diameter of the drum. We can, therefore suppose each diameter to be the axis of an alternating magnet. Every one of these diametral magnets will have its strength nil when on the diameter B C, and maximum when on the diameter E F at right angles to B C.

Examining the magnetic condition of the ring produced by such a rotary alternating field, it appears that it is perfectly quiescent and constant, both as regards sign and strength. On the one half is a north pole, on the other a south; the diameter E F being the axis of these poles and

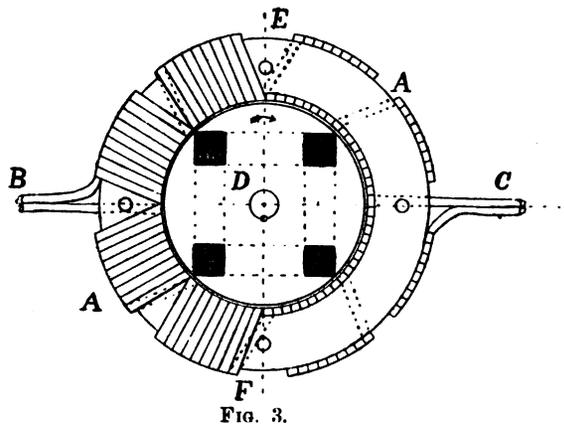

FIG. 3.

the position of maximum strength of field. Here is exactly what is described by our Continental author, and it will be observed that the same magnetic state of the ring could be produced by stationary poles of constant strength. This fact is in itself ominous to the otherwise very plausible deduction that a rotary field of this kind will generate a continuous current in the windings of the ring, but it does not dispose of it.

The field produced by stationary poles could, of course, have no possible effect upon the stationary conductors, but this does not prove that a field outwardly the same, but created by a number of rotating and alternating poles, must be equally ineffective. Actually it is so, but it was this same question that led the writer to make the experiments described later. Yet it is possible to prove the point without experiment; and though it may seem vague and involved the proof is quite admissible, for its rigid accuracy cannot be shown without introducing mathematics.

The proof lies in the fact that the multipolar alternating rotary magnetic field in question may be considered as a combination of a number of bipolar fields, such as the one treated of in the first instance. As we have already seen, under certain conditions a four-pole field is its practical equivalent; and this is the same as a combination of two similar bipolar fields, the one rotating and alternating 90deg. behind the other, in position and phase respectively. It has been shown that the effect of either of these bipolar fields separately is to create an alternating current of double the frequency of the field. Now, if the two effects be added together with due regard to their phase, it appears that they neutralise each other very nearly, if not absolutely. The writer believes that the neutralisation is absolute and complete for every condition, but in any case, if it be not, the result would still be an alternating E.M.F. at the terminals B and C, and not a continuous one. In short, the apparatus is as far off being a solution of this problem of a commutatorless dynamo as it could well be. And seeing that it is only in accordance with certain irresistible mathematical laws that the problem can have no practical solution, this is little to be wondered at.

It was with very little confidence of a successful issue, but rather to settle a doubt of the mathematical edicts raised by noticing how strong was the belief among electrical engineers that the thing was still to be done, that the writer made the following attempt at it. A model was made as shown in cross-section at Fig. 4. Here A A is a carcase of laminated iron built up of stampings ·025in. gauge to about 2in. thick. In the spaces at B and C are exciting coils, the carcase being cut across to permit these coils to be slipped on. The curved portions of the carcase, both upper and lower, are wound closely with one layer of insulated wire, and the four ends brought out to terminals. In effect this is a Gramme ring with the addition of exciting coils. Within the bore, which is 4in. diameter, revolves the drum, G. This also is laminated iron, and it is deeply slotted, so as to present a number of well-defined teeth revolving as closely as possible to the windings, E and F. The action contemplated was as follows: The coils, B and C, were excited by a constant current from a separate source, in a way to produce a north pole, say, at the top half of the carcase and a south pole at the bottom half. The

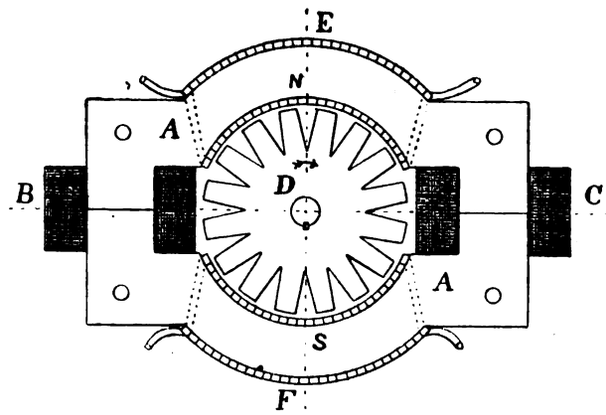

FIG. 4

magnetic circuit was thus completed through the drum, and inner portions of the windings, E F, were immersed in a strong but quiescent magnetic field. The revolving teeth of the drum were to be the means of rotating this field while not reversing the poles of the stationary ring or carcase; for it is clear that each tooth forms an alternating pole whose sign changes as it rotates across the neutral line, B C. The gaps, or slots, in the drum were intended to prevent slipping back of the field against the rotation.

This machine was designed to give 100 volts and a considerable current when run at a moderate speed. Hence it cannot be said that the test was vitiated by restriction of size of the apparatus. The result was negative enough to convince the most sanguine of sanguine inventors. Not a vestige of continuous current, nor apparently of alternating current, was to be detected in the whole or any part of the windings, E and F. This satisfied; but, with a view to completing the answer, the machine was modified, so that the drum might be partially excited by actual alternating currents in windings revolving with it. For this purpose a few turns of stout wire were wound across the drum in each opposite pair of slots and close-circuited. With the drum revolving as before, alternating currents were generated in these closed circuits, and excited a transverse field having south pole, say, at B, and north pole at C. This transverse field, at any rate, would be a "rotary alternating field"; but tests applied to all likely portions of the windings, E and F, within its influence showed no indication whatever of current.

One's small wavering doubt could not withstand so emphatic an overthrow as this, and, of course, it was annihilated, and with it all charm for him of the great will-o'-the-wisp of the electrical engineer.

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INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 16.

At last night's meeting of the Institution the following candidates were balloted for:

Foreign Members.—Charles M. Hall, Pittsburgh Reduction Company, Pittsburgh, Pa.; Christian Vilhelm Kursch, Great Northern Telegraph Company, Libau, Russia; Felix J. L. Mélotte, Quay du Canal 23, Herstal lez Liège, Belgique; Louis de la Pena y Brana, San Roque 8, Madrid, Spain; C. Poulsen, Imperial Chinese Government Telegraphs, Tientsin, China.

Member.—A. M. Billington, London Electric Supply Corporation, Deptford.

Associates.—Frederic J. Anson, 6, Lombard-street, London, E.C.; Henry Carr, Messrs. J. F. Baddeley, St. Petersburg; Arthur Dalby Chamen, "Horton," Mornington-road, Woodford Green; Henry Coles, 10, Arcade, High-street, Swansea; Thomas Davis, 20, Alexander-road-hill, Southampton; Herbert R. Harper, 7, Carden-road, Peckham Rye, S.E.; Thomas Edward Ingoldby, 12, Montague-street, Russell-square, W.C.; Leopold Lucas, 55, Oxford-gardens, Hyde Park, W.; William Maurice, Swanwich Collieries, Alfreton; William Bourchier Nicholson, 1A, Acre-lane, Brixton, S.W.; John Francis Pawsey, 1, Queen's-place, Cork, Ireland; John Horace Reeves, M.A., 85, Eltham-road, Lee, S.E.; Arthur Dudley Southam, 29, Paternoster-row, London, E.C.; James William Speight, 2, Views Grange, Allerton, Bradford; William Edwin Toll, Grove House, Surbiton, Surrey.

Students.—Ernest Bernstein, 29, Red Lion-square, W.C.; John Muir Donaldson, 80, Wellesley-road, Croydon; George L. Eynon, Messrs. J. C. Lyell and Co., 55, Victoria-street, S.W.; Charles C. Garrard, 32, Shrubland-road, Dalston, London, N.E.; Frank Graham, 12, Ladbroke-gardens, Notting Hill, W.; Selwyn Seafield Grant, Central Institution, Exhibition-road, S.W.; E. B. Gray, Perces, Halstead, Essex; Walter Hall, 83, Digby-road, Green Lanes, N.; Leopold H. Harris, 77, Sutherland-avenue, London, W.; T. A. Kerr, 22, Artesian-road, Bayswater, W.; Arnold G. Livesay, 33, St. Charles-square, North Kensington, W.; Edgar Walford Marchant, Central Institution, Exhibition-road, S.W.; H. R. Mott, Hillcrest, Elmbourne-road, Upper Tooting, S.W.; Harry Charles Weston, 80, Chancery-lane, E.C.; Harry George Whiting, 2, Aubrey-road, Crouch End; Arthur Stanley Williams, 288, Uxbridge-road, Ealing Dean, W.

After the premiums had been awarded, **Major-General Webber** proposed a vote of thanks to the retiring president (Mr. R. E. B. Crompton), which was duly seconded and carried.

Dr. Hopkinson, before proceeding with his presidential address, said recent events had made unpleasant revelations to many of them, and had shown them that there were certain peoples who would regard with satisfaction any misfortune that might befall this country either through any international dispute or any little error committed by our countrymen which might involve us in quarrels with those who were formerly our friends. Foreign nations aimed at providing for their safety in these contingencies by a system of compulsory military service, but in England, where we did without that, surely it was the duty of each one of them to consider what he could do towards providing for the safety of his country. Many of them in that Institution possessed aptitudes which might be of great use in the event of war, particularly in regard to their knowledge of electricity and its use for military telegraphs, search-lights, training of guns, submarine mines, etc. He knew that anything they could do would be heartily welcomed by the authorities at the War Office. He had written, among others, to Lord Kelvin, asking him what he thought of the idea, and he had replied cordially approving of the movement, and saying that he hoped and expected valuable results. The Council had that evening passed a resolution "that steps should be taken to render available for the purposes of national defence the technical skill and knowledge of electrical engineers." A committee had been formed consisting of the following: the President, Major-General Webber, Mr. Crompton, Mr. Edmunds, Sir Frederick Abel, Mr. Mavor, and Mr. Erskine. Probably that committee would first of all ascertain what members of the Institution were willing to serve and what time they could give to training. It would also ascertain what places wanted filling in certain corps, and appoint the right men to fill those places, and if there were more men than vacancies, more corps might be formed. If each of them would do his duty according to his opportunities, they would succeed in rendering valuable services to their country.

Mr. Erskine said he was sure a great many of them were in sympathy with the proposal, and could work in one way or another.

It was decided by a show of hands not to discuss the matter further at present.

Dr. Hopkinson then delivered his presidential address as follows:

INAUGURAL ADDRESS BY DR. JOHN HOPKINSON, M.A., F.R.S., PRESIDENT.

When it was suddenly proposed to me that I should a second time be your president, I felt considerable reluctance to accept the duty. This reluctance arose from two causes. Of the first I am ashamed—pure laziness—and of it the less I say the better. The second was a *bonâ fide* doubt as to whether I was specially suitable for the post. But it soon struck me that that was a matter for which those who proposed me were responsible, and not I who accepted, but had not sought the office. But, if I felt a temporary reluctance, do not suppose that I for a moment failed to appreciate the honour which had been done me. To be called by his fellow professional men to fill the chair which has been occupied by men of such distinction as Kelvin, Siemens, Abel, Crookes, not to mention others, is an honour of which anyone may confess himself proud. After once having occupied this chair, to be called to it a second time is a greater honour, for it shows that one's efforts, however imperfect, have been generously appreciated by those for whom they were made. I thank you for the honour, and assure you I will do my best to verify, if I can, the judgment of those who proposed and you who elected me, rather than my own misgivings.

The century which is now just drawing to a close has been a time remarkable above all other times for the extraordinary development of our knowledge of the physical sciences, and in particular of experimental physics and chemistry, and for the extent of the practical application of this knowledge to useful purposes. The century has seen the discovery of the mechanical nature of heat, of the spectroscope, and of the whole of the science of organic chemistry; it has seen the enormous development of the application of the steam-engine, the construction of our railway system, and the supersession of sailing vessels by steamboats. But perhaps the most remarkable illustration of this development is to be found in the science, and its application, with which this Institution has to deal. Consider what was known of the sciences of electricity and magnetism at the end of the last century. The two sciences were then quite unconnected. In magnetism the properties of permanent magnets were known—that is to say, it was known that steel needles could be rendered magnetic by rubbing with a loadstone, and that when so rendered magnetic they would tend to remain in that condition; it was known that if a magnet were broken in parts, that each part would exhibit north and south poles like the magnet from which it was broken; it was also known that the earth exhibited properties of magnetism, inasmuch as a magnetic needle free to move would point, on the whole, to the north; broadly speaking, what we know to-day about permanent magnets was known, and that was about all. The practical applications were limited to the use of a magnetic needle in the mariner's compass. The knowledge of electricity was confined to what is now known as electrostatics. That certain bodies when rubbed exhibited peculiar properties, attracting and repelling each other, had long been observed; and the facts expressed by the hypothesis of positive and negative electricity were known—namely, that two pieces of amber which had been rubbed repelled each other, two pieces of glass which had been rubbed repelled each other, but a piece of rubbed glass and a piece of rubbed amber attracted each other. In a general way the properties of conductors, as distinguished from insulators, were also known in their relation to charges of frictional electricity. Cavendish had made elaborate investigations into the capacity of condensers, the condensers being usually of glass, and being charged by the old-fashioned frictional means. Franklin had proved the identity of the cause of lightning with the cause of the sparks produced by frictional electricity. Just 100 years ago Galvani had made his celebrated experiments showing that the muscles of the limb of a frog were disturbed by contact with a piece of copper and a piece of zinc which touched each other; and that was the only fact which up to that time had ever been observed in the enormous group of facts which now constitute our knowledge of the production of electricity by chemical action. Shortly stated, that was the extent of our theoretical and experimental knowledge of electricity. The practical applications of this knowledge were almost nil. I can recall nothing excepting the provision of lightning conductors as a protection to buildings.

It is worth insisting that the additions to our knowledge of the properties of permanent magnets and of frictional electricity during the century have not been of great importance, and the practical applications of these limited branches of knowledge have been few. If one is asked what uses can be made of our knowledge of frictional electricity apart from the phenomena of currents, it is hard to name anything of importance. In like manner, in regard to our knowledge of permanent magnets, it may almost be said that the advances in practical applications have been confined to improvements in the use of the mariner's compass, which, most important although they are, have had comparatively little share in the changes in our conditions which the last hundred years have witnessed. Almost everything in the way of practical applications of electrical science has been the outcome of subsequent discoveries—the voltaic cell discovered by Volta in the year 1800; Davy's discoveries in electrolysis, Oersted's discovery of the action of currents upon magnets, Ampère's discoveries of the mechanical action of currents upon currents, and Faraday's discoveries in electromagnetism, not to mention the names of eminent men still living. Now, the remarkable thing is that none of these phenomena had ever been witnessed by mortal man. It was not that they were constantly occurring around us, and that the explanation had not been seen; it is the fact that the phenomena had never been experienced. It would seem that the phenomena of electric currents as Volta dis-

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covered them do not occur in nature on any substantial scale. Electromagnets may be regarded as purely a creation of the human mind; so far as we know at present no example of an electromagnet is found in the natural world. The great currents produced by the action of electromagnets have, so far as we know, no counterpart in nature—not only no counterpart in degree, but none in kind. In this respect our science differs much from many others. In mechanics and in heat we may find the phenomenon of which we make use occurring without our aid on an enormously greater scale than we are accustomed to use; changes are constantly occurring around us, and it is conceivable that we might have obtained much of our present knowledge by the aid of observation without experiments. But it is not so with electricity and magnetism. We should be puzzled even now to adequately illustrate the facts we know by observation alone without experiment.

Let us consider for a moment the practical applications which have been made of electrical knowledge during the last 60 years. The first, of course, is the telegraph. What are the scientific facts which have been used in the development of telegraphy? The currents are generated either by chemical means or electromagnetic means. The receiving instruments either depend for their action on the action of currents upon magnets, or, in a limited number of cases, on electro-chemical decomposition. We might put it broadly thus—that, with the exception of the distinction between conductors and non-conductors and certain properties of condensers, the telegraph could do without anything that was known up to the end of the last century, and that it wholly depends upon more recent discoveries. Much the same may be said with regard to the more recent applications—the electric light, electric transmission of power, and the rapidly growing department of electro-chemistry—may all be said to be quite independent of any facts which were known before the year 1800, and entirely based upon discoveries made since. Suppose it were a fact that electricity could not be produced by friction, that we knew nothing concerning the attraction which oppositely electrified bodies have for each other, that permanent magnets did not exist—or, in other words, that iron had no hysteresis—would it make any material difference, so far as we know, in the practical applications of electrical science to telegraphy, telephony, electric light, electric transmission of power, or electro-chemistry? The permanent magnets, which are practically used only in instruments, would be at once replaced by electromagnets, and the apparatus would work just as it does now.

Enough has been said, I think, to show that the knowledge of electricity and magnetism which was possessed by men at the end of the last century, intensely interesting though it was, has not been the parent of the great applications of later days; that the knowledge of the last century has not grown in any great degree upon the lines which existed at its commencement, but that our advances in science, as in practice, were the result of the discoveries which were made since the beginning of the present century.

It has been a frequent practice with presidents of societies devoted to promoting some department of science, theoretic or applied, to deal with the history of the science in their presidential addresses—to show how one idea has led up to another, and how marked have been the advances made. This evening I propose to adopt a different course. What I wish to consider is, how would the theory of electricity have been arranged if the order of discovery of the facts of the science had been other than it has been? Here I owe you some words of apology. You are a practical body more immediately interested in the application of science to the service of man than in the promotion of abstract knowledge. The justification I would offer for my subject is that the science of electricity, whether viewed from the practical or theoretical side, is in a state of extraordinarily rapid advance. The rules of practice of yesterday are of little use to-day, hence more discussion is needed, more publication is needed, than in departments which are in a more stable state. Furthermore, there is no department of applied science in which the connection with theory is so close and intimate. The practical electrical engineer reads eagerly the results of those who, careless whether their work finds application or not, labour to advance knowledge; he attacks these results whether they be expressed in the ordinary speech of men or in mathematical symbols. On the other hand, much of our knowledge of electricity, viewed from the scientific side, has come from those who are concerned with practical application. Nowhere else do we find a closer interdependence of pure science and practice. In what I have to say there will be much that is trite and obvious to the merest tyro in electricity. What I wish to do is to show how the facts of electrostatics can be explained by the facts of current electricity without hypothesis; and it is necessary to rehearse elementary principles. In a complicated subject like electricity, in which the appeals to our senses are indirect, there are open to us many ways of arranging our ideas, any one of which will give us a consistent account of that which we observe. We may take as our fundamental basis one or other of various groups of facts, and deduce others therefrom. The actual arrangement of ideas on the subject depends in a measure upon the accident of the historical order of discovery. Thus, the fact that actions at a distance between electrified bodies were known many years before the phenomena of current electricity and electromagnetism is the reason why that part of the science which treats of such actions is to-day treated first and made the basis of the rest. The time has, I think, come when we may with advantage reconsider our position, and see whether or not our ideas may be more conveniently arranged. The arrangement which is most convenient may no doubt depend upon the phenomena which occupy the most prominent place in the practical use we wish to make of the science. Those facts are best treated as fundamental which are most frequently used, provided they are sufficiently simple. To the practical electrician are the facts of current-electricity or of the attractions and repulsions of electrified bodies more familiar? Surely the transference of energy by current is the agent by which almost every operation he purposes is effected, whilst the phenomena of electrostatics touch him only at points in the theory of electrometers, and so forth.

I propose, then, this evening to sketch out briefly, *ab initio*, how we may base the science of electrostatics upon the theory of current-electricity taken as fundamental. We might, if we pleased, drop the word "current" altogether and substitute another. It seems hardly worth while, but I shall ask you to bear in mind that, if used to-night, it does not connote the idea of anything flowing along the conductor. It is a name for a directed magnitude, and nothing more. I shall have occasion to refer to some elementary experiments, but you will bear with me, I trust, for we are concerned with arranging the subject on as small a basis of facts as is consistent with rigid deduction. Please, then, to banish from your minds all theory on the subject, and let us imagine that the facts of current-electricity are first discovered, and that it is only when these are well developed that electrostatic attractions and repulsions are found out.

In a vessel of dilute sulphuric acid is placed a piece of pure zinc, or of zinc carefully amalgamated, and also a piece of copper, platinum, silver, or carbon, the two plates not being in contact with each other. It is observed that no change takes place; the acid does not attack either plate. The two plates are now touched with the two ends of a wire of copper or other metal; immediately the zinc begins to dissolve in the sulphuric acid, and gas—which, if collected, proves to be hydrogen—is found on the copper or platinum plate. If the plates are large and near together, and the wire is not too long or thick, it becomes very sensibly heated. On separating the wire from either plate, the chemical reaction and the heating of the wire cease. When the wire touches both plates there is then development of chemical energy in the vessel of acid; but a part of this energy appears as heat, not where it is developed, but in the wire connecting the plates. Whether this energy goes across the space of air between the zinc plate and the wire, or whether it goes along the wire, we do not know; but that the two plates should be rendered continuous with each other by a wire or some equivalent is a condition precedent to the chemical reaction and to the heating of the wire.

Let two such vessels of dilute acid, with plates of zinc and copper, be provided, and let the copper in one vessel be connected metallically to the zinc in the other; nothing happens until the copper in the second vessel is connected to the zinc of the first; then both zincs are dissolved, hydrogen is liberated on both copper plates, and the connecting wires are more or less heated.

Again, varying the experiment, let the coppers in the two vessels be connected together and the zincs be connected together: no reaction or heating occurs.

The combination of a piece of zinc and a piece of copper dipping separately into a vessel of dilute acid is called a "galvanic cell," or element; a series of elements connected together, copper to zinc, is called a "galvanic battery." Galvanic elements and batteries take a multitude of forms: the zinc may be replaced by another metal—for example, cadmium—and the copper by platinum; many other liquids than dilute sulphuric acid may be used; but all galvanic batteries have this in common—to cause them to work, the chain or circuit must be completed by a wire touching the zinc at one end of the series and the copper at the other, and then chemical reactions occur in the cells, and heat is liberated in the metal connections. The zinc and copper plates, or their equivalents, at the ends of a galvanic battery are called "poles."

(To be continued.)

A vote of thanks was proposed to Dr. Hopkinson for his interesting discourse, which was seconded and carried unanimously.

The next meeting will be held on Thursday next, the 23rd inst., when the discussion on the papers recently read by Mr. F. Bathurst on "The Electric Wiring Question," and Mr. Sam. Mavor on "Concentric Wiring," will be resumed. These papers were given in our issues of November 29 and December 13, 1895.

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MOTORS IN FACTORIES.

It has taken at least ten years for some of our foremost electrical manufacturers to discover that there will be a gold mine in the coming use of motors. We do not mean the use of motors for traction purposes, but for factory work. For many years past we have contended that in many instances the use of electric motors would be more economical than the use of gas or steam. Our contention is being rapidly proved to be correct. It may be said at once that we should not pit the electric motor against steam when the load was constant: only in the case of factories with a large number of machines thrown periodically in and out of gear and run by belting from countershafting. Mr. Crompton discusses this question in the current number of *Cassier's Magazine*, which number, by the by, is devoted entirely to electrical matters. We shall quote somewhat largely from Mr. Crompton's article, but before doing so must call attention to the work of a gentleman whose name has lately been very much in evidence. Whatever be the claims of Sir David Salomons to our consideration, there is one which will be freely granted. He has spent large sums of money and given largely of his time to prove his opinions that electrical energy gives us the best artificial light and the best motor power for machines used intermittently. He many years ago fitted his estate workshops with motors, and demonstrated both their economy and feasibility in working. Some eight or nine years ago a canvass was made of a certain part of London, but no English firm would undertake the distribution of power in that district without guarantees which could not be forthcoming. Yet when the subject came to the ears of American financiers, they professed themselves willing to carry out the work. The promoters of the scheme, however, did not care to work in this direction, and the matter fell through. During the past eight years hundreds of horse-power have been changed from steam to gas, and there would, therefore, be in this particular district less support now than was possible eight years ago.

But in other places matters have not advanced so rapidly. Users of steam power had to be convinced that steam could be replaced, and such conviction could not be obtained by isolated instances of success. It was left for electrical manufacturers to show their confidence in their own work by installing motors in their own shops. This some of them have done, and the installations have proved singularly economical. Abroad, one or two well-known factories, where steam must otherwise have been used, are trusting entirely to motors, such as the small-arms factory at Hersthal and, again, at Lugansk, while in many other cases, with water power available, electrical apparatus only has been installed. England, as usual in some electrical things, has in this watched and waited, but the engineers, having now satisfied themselves as to the efficacy of the apparatus, will no doubt push their wares with vigour and success.

Mr. Crompton, in his article discussing the figures of Prof. Kennedy, says: "Although Prof. Kennedy, the president of the Institution of Mechanical Engi-

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neers in England, in his address to that institution in April, 1894, considered that in a factory, with the useful work taken at 100, the total indicated horse-power of the steam-engines may be taken at 145, the author finds that this proportion is far too favourable, and is true only in the case of a limited number of establishments where the load is steady throughout the working day. In most cases the following figures more closely represent the actual state of affairs:

Average useful work	100
Average wasted in belts and shafting	75
Average wasted in engine friction	60
Total average indicated horse-power	235

"If the author's assumption is approximately correct—and he believes it to be so in the majority of cases in works such as we are now considering—and if we apply it to a factory which requires an average of 500 h.p. net delivered at the tools, we find that the average indicated horse-power which probably would be spread over three steam-engines would be 1,175. We find, however, that in order to work this plant for 2,950 hours per annum, taking coal at 12s. per ton, the coal bill would work out at £2,260; the probable wages bill, £1,480; the stores, £600; and the repairs and depreciation of plant together, £1,600; making a total cost per annum of £6,000 for 500 net horse-power delivered at the tools, or at the rate of £12 per annum per horse-power. Now, what can we promise by substituting for this arrangement a modern electrical equipment? In the first place, although we should still divide our total power between three engines, we do so only in order to avoid the risks of a break-down affecting the whole establishment. We should make these three engines identical in form and size, and we should place them together, so that they could be worked by one attendant. We can claim for modern generating plant that it can be made with certainty to specification to produce the electrical horse-power delivered at the terminals of the various motors, distributed all over the works within a radius of 500 yards, with a consumption of 2½lb. of coal per hour; and it is easy to show from the actual records of Messrs. Siemens, Messrs. Crompton, and others that the proportion of useful work done at the tools may bear to the average indicated horse-power of the engines the high proportion of 500 : 680, so that the total coal bill in this case would be only £1,080; wages, £375; stores, £260; repairs and depreciation, £1,300; making a total per annum of £3,000, or £6 per annum per net horse-power, which is exactly half the cost of the older system. It will be seen that a very large share of the above saving is on the labour bill, and that, consequently, in the cases where fuel is exceptionally cheap, the saving would be diminished; but even if we take fuel at the extremely low price of 6s. per ton, the correction in the above figures would be only such as to reduce the cost of the older system to £10 per annum per net horse-power, and in the case of electric transmission to £5. In this case, too, it is here shown the saving effected may be £2,500 per annum."

We can only hope that these figures of Mr. Crompton, substantiated, as he tells us they are, by his own experiments and those of Messrs. Siemens, will assist in causing greater examination to be made by consulting architects and engineers into the question of fitting up factories with motors. There is one great point to be insisted upon. Competition has nowadays cut manufacturers' profits down to a very low point in many directions. Where new works are being built it is the interest of the proprietors to arrange everything for the most economical production, and if the geographical position is right the newly-equipped mills ought always to have the pull over older concerns, in that the machinery employed ought to be more efficient. Thus, a great impetus to electrical work ought to come from the directions named—architects and consulting engineers who are called upon to design the new works.

WHAT, WHEN, AND WHERE.

Physical Society.

January 24, 5 p.m.—At Burlington House. 1. Exhibition of geometrical instruments by E. Scott and Signor Monticolo. 2. "Resultant Tones," by Prof. J. D. Everett. 3. "Experiments with Incandescent Lamps," by Sir D. Salomons.

Institution of Civil Engineers.

January 17, 8 p.m.—At Great George-street, Westminster, S.W. Students' meeting. "Iron Tunnels," by W. O. Leitch, jun.
January 21, 8 p.m.—Discussion on the Hon. R. C. Parsons's paper on "The Sewerage Works of Buenos Ayres."

Royal Institution.

January 17, 8 p.m.—At Albemarle-street. Weekly meeting. "More about Argon," by Lord Rayleigh.

Society of Arts.

January 20, 8 p.m.—At John-street, Adelphi. Cantor lecture, "Alternate-Current Transformers," by Dr. J. A. Fleming, F.R.S.
January 22, 8 p.m.—Ordinary meeting. "Supply of Sea-Water to London," by F. W. Grierson.

North-East Coast Institution of Engineers.

January 17, 7.30 p.m.—At the Literary and Philosophical Society, Newcastle on-Tyne. "Counter Sinking in the Shipyard," by R. H. Muir.

THE ARC LIGHT.*

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S.

LECTURE II.

(Continued from page 49.)

ENERGY SPENT IN THE ARC.

Before passing away from the relations established above let us pause for a moment to consider the energy question. You may sometimes find it said, and it is perfectly true when you are dealing with a fixed resistance, that the energy spent by a current is proportional to the square of the current. That is, in fact, Joule's well-known law. If you double the current through a given resistance, the amount of energy you have to spend is fourfold; and if you were heating carbon you would perhaps argue that the light would be fourfold. But here we are confronted with the fact that, whatever the law might be supposed to be, when the current is doubled the light is doubled, not quadrupled. The light does not go by the square of the current. There is no paradox or puzzle in the circumstance, if one has once realised that important point developed in the former lecture that the resistance of the arc is by no means a constant; that if you treat the arc as possessing a resistance simply, then you must say the apparent resistance of the arc for a given length varies inversely as the current. When you double your current, the resistance of your arc becomes halved. If, however, you treat the problem in the other way (which seems more rational), as involving the consideration of a back E.M.F., seeing that the back E.M.F. is a nearly constant quantity, you

* Cantor lectures delivered before the Society of Arts.

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must calculate the work done in another way—namely, as work done in driving a current against the opposing E.M.F. There would, in fact, be no work done at the crater surface if there was not located there something in the nature of back E.M.F. To put the thing in simple mathematical form : If V represents the number of volts against which you are driving the current—*i.e.*, the true back E.M.F. of the arc—and C stands for the number of amperes of current, then the work done per second is the product of those two. If we were dealing with a constant resistance, V itself would be proportional to the current ; hence the product of the current into V brings the current twice over into the expression for the work done. Where, however, we are not dealing with a constant resistance, there being a fixed voltage to do work against, we must use the law in this shape just given ; the work done in driving a current against a back E.M.F. is the product of the two. If the voltage against which you are working is a constant, it follows that the power expended is proportional simply to the current, not to its square, a conclusion which is justified by the fact that the amount of light given out is proportional also to the current, other things being equal.

Influence of Crater in Efficiency of Lighting.

Mr. Trotter's admirable paper deals, amongst many other things, with one very interesting practical point. Some years ago it was proposed by Sir James Douglass—a name so well known in connection with lighthouse work—to employ, for lighthouse illumination and projector lamps, a form of carbon rod different from that which had been previously used. If I am rightly informed, the old carbons originally used in the lighthouses in Dungeness and elsewhere were made from battery carbon or retort carbon, sawn into square sticks about a ¼in. each way. They were afterwards replaced by round rods of somewhat larger diameter, and for very powerful lights by still larger rods. Sir James Douglass seems to have thought he would obtain a better light, a more central, steady, luminous patch to project through his lenses, if he could avoid the wandering of the arc over the large surface of the crater. The wandering of the arc, when the carbons are too thick in proportion to the current used, is one of the things familiar to all who work with arc lamps. If you employ a larger size of carbon rod than is necessary for the size of the crater—that is, proportionally to the current—the crater will not be fully filled with light, but a luminous spot of the light will wander round and round unsteadily in the crater. Then at irregular intervals the crater wall will give way, sometimes on one side, and sometimes on the other, and you have loud hissing and extreme unsteadiness. It occurred to Sir James Douglass that if he fluted his carbons he would obviate the formation of a crater rim ; he would, instead, obtain a crater with an edge consisting of points at regular intervals with spaces between, and presumably a more steady arc. Mr. Meyer has sent me these two specimens of Sir James Douglass's lighthouse carbons. They look to me as if they were taken from an alternating-current lamp. Neither of them has a well-formed crater. There is here a second pair of fluted carbons, intended for a smaller lamp, which have the same peculiarity. Mr. Trotter examined the arcs made by using fluted carbons, and, reading between the lines, I judge that he was not favourably impressed with the arc produced under those conditions. The fact is, if you want a good light you must have a good crater. This I take to be the explanation of the attempt to improve carbons by coring them—that is, by making them tubular, and filling the bore with carbon of a softer quality. This device appears to have a beneficial effect in anchoring the arc, and preventing it from wandering round the crater, by giving it a kind of foothold. The soft core tends, in fact, to promote the formation of a crater, and consequently to steady the arc. With very short arcs, and arcs that hiss, the crater is generally very irregularly formed and much deeper as a cup than is the case in the long arcs. The mushroom growth that is observed with hissing or short arcs is formed at the expense, in fact, of material torn up from the bottom of the crater. This is but one of a number of irregular phenomena which really need not engage us further, but must, however, be taken into account in any complete account of the optics of the arc. The rapid changes of colour in the flame whenever the arc is in an unstable state are very curious.

Whiteness of the Arc Light.

Another very important point in the optics of the arc is its constant degree of whiteness. It was found by Captain Abney long ago, in 1878 or 1879, I think, that the relative amounts of the radiation of different colours—red, blue, yellow, and so forth—in the arc light are always the same, other things being equal ; the arc is, in fact, of a constant degree of whiteness, so much so that for years he has used it as a standard of comparison in his researches on colour photometry. This constant degree of whiteness, so far as it is true, is evidence of constant temperature, or possibly of constant temperature coupled with constant emissivity. It is a curious point that when the arc wanders from spot to spot, in the rapid fluctuations that sometimes occur—about which I shall have something to say presently—the apparent whiteness of the arc remains the same, although the intensity of it may vary—that is to say, one patch may look whiter than another patch by having more light coming from it, yet you do not get a change of colour. You cannot say that it is any redder, any greener, or any bluer—there is simply more light coming from it ; so that it appears that there may be something comparable to constant temperature, and yet different emissivities at portions of the same surface.

So three years ago Mr. Swinburne and I, independently, suggested that, seeing the arc is always (or was supposed to be always) of a constant degree of whiteness, the very best standard of white light would be that of a fixed area or patch selected from the crater of the arc (by means of a diaphragm having a very small hole in it). We could desire no more perfect standard of white light than one always equally white and of a fixed size. This suggestion of using a square millimetre, let us say, of incandescent carbon at arc temperature, as the standard of white light, was a very fascinating one. I did my best to have it taken up in Germany by the late Prof. Von Helmholtz. The last letter I ever had from him was on this subject. The suggestion has been put to trial both by Mr. Trotter in London and by M. Blondel in Paris. The result of it all is that, fascinating as the idea may be, it will not do ; not only are there inherent difficulties at the very high temperature that prevails in getting the light through the small diaphragm placed close up to the arc, but, as Mr. Trotter has found, the variations of the light are so extraordinary that at present it seems unlikely that we shall ever in this way attain a true standard of invariable amount.

What, then, are these variations about which I am speaking ? In the first place, if the carbon contains impurities the light is of lower intrinsic brightness. The soft variety of carbon used as a core in the cored carbons shows as a duller patch at that part of the crater. As an experiment I had an arc light carbon cut down lengthways ; there was fixed up against it a pencil made from the best graphite one could get—a pure natural graphite. This combination was, in fact, a carbon rod, half of which was ordinary arc light carbon and half of which was plumbago. Using this compound rod as a top carbon I found the crater to be unequally illuminated over the two halves. The supposed pure graphite shone less brightly ; it was white ; but it shone with a different amount of light from the patch of ordinary arc light carbon, just as the cores of the cored carbon pencils shone with a different degree of brightness. In using cored carbons you, in fact, sacrifice a little of the candle-power in order to obtain steadiness. It is a not unimportant fact that impurities lower either the temperature or the emissivity of the surface, and the result is a want of standard condition. The more recent discovery of Mr. Trotter—presently to be described—is much more upsetting.

Luminous and Non-Luminous Energy.

The energy that is given out by surface light is, unfortunately, not given out only as light. There is other energy of a non-luminous kind. I am not exaggerating when I say that only about one-twentieth or one twenty-fifth of the energy supplied to the arc, and emitted at the crater, is effective in producing illumination. To put it in a popular way, for every ray of visible light you have given out you have 24 or 25 rays of invisible light—that is to say, of heat—so that the luminiferous efficiency of the arc is something like 4 or 5 per cent. only. Of the energy spent, there is only some 4 or 5 per cent. which is effective in producing illumination. Here is a diagram intended to illustrate that. Using a proper kind of prism to disperse the rays, one may produce a spectrum. Such a spectrum has been given by various authorities : Müller, Tyndall, Abney, and Langley. From the recent researches of the three last named I have prepared the diagram (Fig. 19), in which different rays of luminous and non-luminous light are supposed to be plotted out before you. In this case the luminous spectrum occupies a very small part of the diagram. The smallest of the three curves is Captain Abney's curve of relative luminosity or sensitiveness of the normal eye to different kinds of light. The eye is most sensitive to light in the yellow or greenish yellow, and least sensitive to the red, and to blue and violet. What proportion do these radiations to which the eye is sensitive, and which are effective, therefore, for the purpose of illumination, bear to the whole amount of radiation ? Only this very small area underneath that curve of luminous energy as compared with the area underneath the tall black curve, which represents the spectrum of the total emission of visible and invisible rays from the arc. Right away down in the *infra* red you have this enormous development of waves of slow period—heat waves in fact. They are given out in far greater abundance than the waves which affect the eye as luminous waves. The ragged curve which is intermediate between the others represents to the same scale as the arc spectrum, a spectrum for an equal amount of light if derived from the sun. It shows how waves of a certain length are absorbed off by the intermediate atmosphere between us and the sun. This curve is taken from Langley. One of the things we have to look forward

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to in the development of artificial light is the production of lamps which shall be of a higher efficiency than the arc lamp. They must, for an equal amount of energy supplied to them, emit a far greater percentage of waves of a length that will affect the eye as luminous waves, and a far less percentage of those longer waves which do not help the illumination, but which only warm us. Such a transformation has been wrought for gas lighting in recent years in the introduction of Dr. Auer's incandescent mantle. He discovered a material whose emissivity, at the temperature of the gas flame, is higher than that of the carbonaceous matters in the ordinary flame of coal-gas. It emits a greater percentage of waves of the sorts that affect the eye, and a lesser percentage of the non-luminous waves. The vacuum tube lamps, and their modern varieties, such as Tesla's

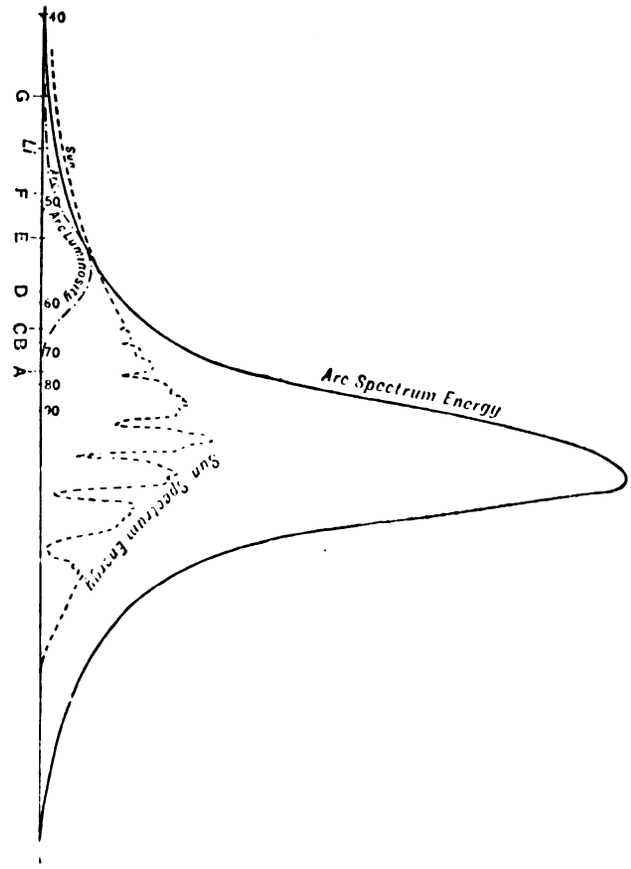

FIG. 19

lamps and Ebert's luminescence lamps, are attempts to procure a better specific luminescence from a given amount of energy.

ALTERNATE-CURRENT LIGHTING.

I have on the table here the means of producing an alternating-current arc. The alternating current may be turned on, and then the arc struck by hand between the two carbons. By means of a choking coil I am able to regulate the amount of light given out by the current passing through the arc, and with this lens I will project the arc on the screen, so that you may see the difference between the normal arc, as made with a continuous current, and the alternating-current arc. You will find that, in the latter case, the tips of the two carbons are heated almost equally to whiteness, and assume almost identical shapes. If the carbons are of the same quality, the heating and the consumption of them would be precisely alike, except for the slight difference due to the circumstance that the ascending hot gases around the arc make the upper carbon hotter. The two luminous areas on the two tips are of equal area and equal whiteness, and, as projected on the screen, appear as two luminous patches of equal size; but in neither the upper nor the lower carbon is there either a well-developed crater or a well-developed peak. The fact is, that each tip has to serve alternately as crater and as peak, so that the resulting form is a compromise. We are able then at once to recognise whether the arc is being supplied by a current that is continuous, or by one that is alternating. The distribution of light in the space surrounding the arc corresponds to this difference in the distribution of the luminous surfaces. Whereas the continuous-current arc throws its light (when the crater is at the top) mainly downwards, with a maximum at 40deg. to 50deg. below the horizontal, the alternate-current arc throws its light almost equally upwards and downwards, there being two maxima, one above and the other below the horizontal. But with the alternate current it is possible to cause the light to be artificially projected downwards on the whole, either by placing a mirror around the upper carbon (as in Fig. 12) to reflect down the light that is emitted upwards, or less advantageously, by employing a thicker top carbon, and a thinner bottom carbon. There is another important difference between the light of the alternate-current arc and that of the continuous-current arc which affords a ready means of discriminating between them. The alternate-current arc is subject to a regular periodic fluctation. The rapidly-reversing current pulsates, and the arc pulsates too. The current actually stops and then starts again in a reversed direction some hundred or more times in a second. The flame does not actually go out, but it dies down, and before it has had time to go out the current has started again in the opposite direction. If the flame did not thus persist, it would be impossible to operate arc lamps at all by means of alternate currents. I can show you by a simple experiment this fact of persistence. I take here a continuous-current arc, and clamp the carbons immovably at the normal distance apart while the arc is burning steadily. Now, by means of a reversing switch, worked by hand, I suddenly reverse the current. The light blinks at the instant of reversal, but does not go out. An interruption of, say, one-hundredth of a second does not put out the light: the flame had not time to die away. It is not accurately known what the maximum duration of an interruption may be, but it is known that arc lamps cannot be practically operated with alternating currents if the frequency is less than about 40 periods per second—that is to say, if there are fewer than about 80 reversals per second. That the light of an alternate-current arc does thus fluctuate can be made evident in the simplest possible way. If one whirls a white rod, or waves it rapidly up and down, in the light of the arc, one perceives a succession of images. When a rod is made to throw its shadow on the screen, and is then rapidly waved to and fro, the shadow is observed to be broken up into a series of maxima. A silver coin tossed into the air shows a succession of images as it falls. By merely shaking my hand in the light of the alternating arc, I appear to possess an enormous number of fingers. The current here used is derived from the generating station at Deptford, where Mr. Ferranti's machines work with a frequency of 85 periods per second. Consequently we have 170 successive images per second for any quick-moving body. I have frequently found out whether arc lamps were worked with alternating currents or by continuous currents by standing under a lamp-post at night, and twirling my walking-stick. You can tell an arc lamp that is alternating by another circumstance—viz., that in addition to any fizzing or hissing that there may be, you hear a kind of continuous hum. In the lamp now before you you may hear the hum of the machines at Deptford. If I increase the current, you will hear it still more loudly. The loudness of the hum also depends on the form of the individual waves of current.

EFFICIENCY OF ALTERNATE-CURRENT ARCS.

There has been some discussion of late on the question whether the alternating-current arc was as efficient as the continuous-current arc—that is to say, whether for a given consumption of energy you obtain an equal proportion of light. Prof. Fleming has made measurements, and written learnedly on the subject. I do not dispute the accuracy of his observations, or that of others who had made observations on the subject. I wish to give you an absolutely *à priori* view. This is a matter I have not measured myself, therefore I am absolutely unprejudiced, but it seems to me perfectly absurd to suppose that, if you take the right mechanism, select the right size and quality of carbon, and use it properly by the light of experience, applying the appropriate amount of current, there will be any difference whatever in the efficiency of the alternating-current arc and that of the continuous-current arc. I do not see where there is room for any difference. At one time it was supposed that incandescent lamps were not as efficient if worked with alternating currents as with continuous currents. That heresy was long ago exploded by Profs. Ayrton and Perry when they showed that it was merely a question of getting the right voltage appropriate to the measurement lamp. I am bound to say I think the same kind of considerations apply here also. Since the heating effect of a current is proportional to the square of the current strength, what difference does it make, what difference can it make, whether the current is going in one direction or in another? If you spend the right amount of energy on the right amount of carbon by raising it to the right amount of temperature, you are bound, other things being equal, to have equal results. If you arrange your things badly so that some of the energy is not spent, as it ought to be, on heating the carbon white hot, I grant you may get a different result; but it seems to me, from *à priori* reasoning, to be absurd that you should not have equal efficiency with the alternating current as with the continuous current.

SPECTRUM OF THE ARC.

My next experiment is to project upon the screen the spectrum of the arc. Arrangements are made in the following way: First of all, the arc is produced inside a lantern; it is then focussed by a lens upon a small auxiliary screen 3ft. away from the arc. This screen has a narrow slit down it, the image of

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the arc being formed on a slit. Through the slit, then, there passes out a vertical slice out of the arc. In this slice we shall have a bit of the top carbon, a bit of the arc in between, and a little bit of the bottom carbon, one above the other. The light of this luminous slice is then passed through a prism, and on through a focussing lens, producing on the screen a spectrum of that portion of the arc complete, from the red end on the right to the violet end on the left. Now notice what that spectrum consists of. The upper luminous streak is the white light from the crater spread out into its various component colours in their proper order one after the other. The light of the bottom strip, which also goes from red to violet, is the light from the peak of the negative carbon. The apparently dark patch in between them shows you the spectrum of the pale flame or arc. Only those who are near can see it properly, but in this comparatively dark tract between the upper and lower carbons the spectrum shows a number of nebulous bands, two in the green, a brighter one in the bluish green and another one about the end of the blue or beginning of the violet. Those bands are the well-known spectra of the element carbon, so that we have here the optical proof that the flame between the two carbons consists of carbon vapour in an incandescent state.

THE ENCLOSED ARC.

More properly belonging to the subjects comprised in my first lecture is the matter next to be mentioned of the peculiar effect produced on an arc by burning it in an enclosure which prevents access of fresh air. The properties of the enclosed arc have been investigated by Mr. Marks, to whom is due the disposition which I here exhibit. It may be fitted to any ordinary form of arc lamp. The lower carbon projects through and supports a metal disc with a raised rim, on which stands a small glass jar about 3in. in diameter. The upper carbon comes down into this through a rude stuffing-box at the top of the jar. The arc is formed in the usual way, only it happens to be enclosed, so that the air cannot come in from below or readily pass through the rough stuffing-box at the top. The air in the jar is in a few minutes deprived, by combustion, of its free oxygen; so that from that time onwards the arc is burning in an atmosphere that will not support combustion. As a consequence the actual waste of carbon is much smaller than is usually the case. In some experiments on the ordinary arc, made by Mr. Preece, with a Brockie-Pell lamp, using about 6½ amperes at 50 volts, with a 13mm. carbon for positive and an 11mm. carbon as negative, the mean consumption per hour per ampere was found to be, for the positive carbon, 3·52mm. (length), or 0·504 gramme, and for the negative carbon, 2·86mm., or 0·176 gramme. (Dr. Strecker gives, as the experience in Germany, 0·75 and 0·375 gramme respectively). Now, this consumption of carbon may, as Mr. Marks has shown, be greatly reduced by simply preventing access of fresh air.

This actual lamp has been tried. My friend Prof. Walmsley, of Edinburgh, has been good enough to communicate to me the figures obtained during a run of 14 consecutive hours. The carbons were those ordinarily used in Brockie-Pell lamps, but the actual lamp used was of Brush-Sellon pattern. The current was 10 amperes, and the mechanism was adjusted to give a rather long arc. Of the positive rod the length consumed per pair when burning open was 47mm.; when enclosed, only 2·84mm. Of the negative carbon, the length consumed per hour when open was 18·7mm.; when enclosed, only 0·62mm. The positive carbon when burnt in this way only burns at about one-tenth of the rate at which it burns away in air, while the negative carbon only burnt away at about one-thirtieth of the rate at which it burns away in free air. The total consumption when enclosed, is, therefore, about one-twentieth part of what it would be for the same current when the arc was burning in open air. There is, however, one drawback to the use of an enclosing vessel like this—viz., that the interior of the vessel gradually becomes coated with a brown dust which obscures the light On that Prof. Walmsley made some observations, and came to the conclusion that after 18 hours the light was approximately about half of what it would have been without the globe. As a matter of fact, it is a brown deposit, which cuts off rather more of the green waves than it does of the red waves.

(To be continued.)

Invention.—Mr. E. P. Thompson continues in the December number of *Electric Power* his endeavour to reduce to principles the process of making new inventions. He classifies inventions under various heads, such as "Imitation," "Change of Material," and so on. When "Faure plastered the lead plates of an electric battery with red lead, and saved several weeks and months in the formation of lead compounds by the electrolytic process," it was a "striking example of imitation." Perhaps; but it does not help much in teaching how to invent.

REPORT ON THE LEEDS TRAMWAYS BY DR. J. HOPKINSON, F.R.S.

Below we give the report recently presented by Dr. Hopkinson to the Leed Highways Committee It may be remembered that this committee in October last passed a resolution, "That the necessary steps be taken for the extension of the Roundhay tramway to the Canal Gardens at the Park; that the overhead electric traction system be continued from the junction of the Roundhay tramway at Sheepscar along North-street and Briggate; that in Boar lane, from Briggate to the Yorkshire Banking Company's premises, an installation of the conduit system be laid; that the overhead system be then continued along Wellington-street and Kirkstall-road to Kirkstall Abbey, and that central poles be used wherever practicable."

Dr. J. Hopkinson was then asked to consider the matters and reported as follows:

I have paid two visits to the city for the purpose, and have inspected the tramway from Kirkstall to Roundhay, the existing electric station at Burmantofts and the proposed sites for the generating stations at Armley road and Crown Point road. The distance from Kirstall to Roundhay Park is seven miles, and hence the length of a complete round trip will be fourteen miles Having regard to the fact that a considerable portion of the distance run is through the city, it is clearly impossible to maintain a high speed. I do not think that a greater average speed including stoppages, than seven miles an hour can be calculated upon. I therefore assume that the cars will be run at an average speed of seven miles an hour, including stoppages. If this be so the average time for a car to complete the circuit from Kirkstall to Roundhay Park and back again will be two hours. As the cars run at intervals of 7½ minutes, this will require 16 cars constantly running, or, allowing four cars as spares, a total of 20 cars. This number, will, of course, be the same whatever system of conductors were used.

Where the Poles Should be Placed.—The questions with regard to the conductors which remain open are, whether, with the overhead conductors, poles in the centre of the roadway should be used, or poles at the side, with wires crossing the street, from which would be suspended the conducting wires which supply the cars. A good example of centre poles can be seen in the arc lighting poles of the St. Pancras Vestry. These are placed in the middle of the roadway, and are protected by a small island of pavement from danger from passing vehicles. This, in my judgment, forms a very neat arrangement. The presence of the poles does not in any way obstruct the traffic, but rather facilitates it by dividing it on the two sides of the road. The islands, too, are convenient for people crossing the roadway, giving them a place of safety if the traffic is at all crowded. The present distance between rails is 3ft. 3½in., the width of the cars 6ft. 8in. to 7ft. Deducting 4ft. 8½in., the gauge of the rails, the cars project 1ft. to 1ft. 2in. on either side into the space of 3ft. 3½in. between rails. This will of course be increased, say, to 4ft. 6in., which will leave from 2ft. 2in. to 2ft. 6in between passing cars. I am informed that a minimum width of 34ft. between the kerbs will be secured from the end of the present electric tram to Kirkstall. This would be divided as follows:

Side space.	Track.	Space between rails.	Track.	Side space.
10ft. 0½in. ..	4ft. 8½in. ...	4ft. 6in. ...	4ft. 8½in. ..	10ft. 0½in.

The car would project 1ft. to 1ft. 2in. into the side space, leaving 8ft. 10½in. to 9ft. 0½in. clear for other vehicles. The appearance of a line of centre poles would be much better, in my judgment, than any other arrangement, and they could further be used for arc lights, if desired. I should, therefore, prefer centre poles, but this would not in any way interfere with the use of wires stretched across the streets in places where poles might from any cause be inconvenient. This would be particularly the case where there are points or where rails cross each other. It has been suggested that the supports carrying the overhead conductors, be they poles or cross wires, could be placed at a greater interval than has hitherto been usual. This is just one of those practical points for which one must rely upon experience, and I should not recommend any deviation from the results of such experience—that is to say, the poles should be placed at intervals of 40 or 50 yards.

The Conduit Systems.—When I was recently in the United States I gave special attention to what had been done in underground electrical conduits for tramway purposes. There are two such conduit systems in Washington, and another has been laid down in New York. Some years ago I also gave special attention to the conduit system in Budapest, and visited that town for the purpose of making a careful inspection. The conduits there laid down have, on the whole, worked extremely well. The principal objection to the conduits, as laid down in America, is their great cost. I was informed that those in Washington cost about £20,000 per mile of single track. Other serious objections are that they necessitate a slot in the roadway of about ¾in. wide; and in the particular case of Leeds, where it is proposed to combine an underground conductor in one part of the tramway with an overhead conductor in another part, there is the further objection that it would be necessary to stop the car for a very appreciable time for the purpose of detaching or attaching the plough, as it is called, which makes the connection with the underground conductors. These objections, of course, are by no means insuperable if no better method could be found. There is, however, a method of supplying current to tramcars which is free in a greater or less degree

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from all three of these objections. This method, to my knowledge, exists in three different forms in the hands of three different American firms. For the present purpose I need refer to only one of them. According to this method, the slot is entirely absent, and its place is taken by a series of cast-iron pieces projecting very slightly indeed above the roadway at intervals of about 13ft. from each other. These pieces are only connected to the supply of electricity at times when they are covered by the car; at all other times they are inoperative and dead, so that no shocks can be received from them either by horses or pedestrians The cost of this system is considerably more than the cost of overhead conductors, but is considerably less than the cost of a well-laid conduit. The slot, as already stated, is absent, and it would be possible to so arrange matters that the transference from one source of supply of current to the other would be made without actually stopping the cars. If it were found that a stop were desirable, as a matter of convenience, this might be made exceedingly brief. A tramway has been working in Washington on this system for 18 months very satisfactorily. I inspected both this tramway and an experimental tramway in the Westinghouse works at Pittsburg. I should, therefore, recommend that for the tramway through Boar-lane the enclosed conduit system, such as that to which I have referred, should be adopted. All other conductors than those for the delivery of current to the cars should be laid underground.

Electrical Pressure.—The next question is that of the electrical pressure at which current is to be supplied. Five hundred volts has been sanctioned, and is used in Bristol, and I have ascertained that it is the intention of the Board of Trade to sanction this pressure as the maximum pressure in other cases. There is no reason why any person should come in contact with the supply conductors at all, and I know by personal experience that the shock from 500 volts, though disagreeable, can be received with absolute impunity. The economy obtained by using the highest admissible pressure is, of course, considerable when transmission has to be made over a substantial distance, and I should therefore recommend that 500 volts be the working pressure for the Leeds tramways.

The current will return from the cars to the generating station by the rails and such additional conductors as may be necessary. This requires care in carrying it out. Without such care it is obnoxious to the objection that a considerable part of the currents may return from the cars to the station through the earth instead of through the rails, and in so doing they may cause, first of all, electrolytic action upon gas-pipes, which may in time be sufficient to eat holes into the pipes and cause serious danger from leakage: secondly, these earth currents may disturb the telegraphs; and, thirdly, they may disturb the telephones. With regard to the telephones, the cause is not solely currents returning through the earth, but is in part inductive. The Legislature, however, has put the duty of protecting themselves upon the Telephone Company, and so far as it is concerned it is only necessary to take such precautions as are convenient and inexpensive. With regard to the gas-pipes and to the telegraphs, the Board of Trade have laid down certain stringent regulations which in their opinion should prevent mischief, and which can be effectively carried out by proper care. In my judgment however, it would be well to so construct the system that the Board of Trade conditions should be more than fulfilled. This can be done by giving sufficient attention to the laying of the rails and to their conductivity, and to the general design of the system.

The Generating Plant.—Of the general questions that have to be considered, the next is that of the location of the generating plant. You have in Leeds a number of refuse destructors, in which a considerable amount of heat is generated. Is it worth while to utilise this heat? The primary question is, How much can we save thereby? I shall show presently that for working the seven miles of tramway to be first put down, the indicated horse-power will be about 200, or rather less. This will require a daily consumption of about four tons of coal. Coal in Leeds is cheap—I understand about 6s. per ton—and hence the total annual saving, if the coal bill could be totally abolished, would only amount to some £450 a year. When the whole town is supplied with electrical tramways, the power required will be increased fourfold, or slightly more. The saving then effected would be some £1,800 a year. To effect this saving, however, certain serious inconveniences will be caused. In the first place, in order to supply the power required for the whole town, more than one destructor station would have to be utilised, and hence there would be at least two generating stations instead of one, which would be all that would be required if the heat were generated from coal. Special boilers would have to be provided for the purpose of generating heat from the products of combustion of the destructors, but this would not relieve the city from the necessity of putting down additional boilers to generate steam from coal, because the destructors do not now work, and I understand there would be difficulty in causing them to work on Sundays. It may be suggested that electric accumulators might be used for effecting the supply of current on Sundays, these being charged during the week from the destructor stations. It would, of course, be possible to accomplish this, but at very great cost; for the accumulators would have to store the considerable amount of energy required for nine or ten hours' running These would, therefore, have to be of a very large size, and correspondingly expensive. In fact, if the destructors were used, I should say, provide for Sundays by a special system of boilers, and not by accumulators. From what I have stated, however, it can very readily be gathered that a single generating station, working in the usual way with steam-boilers heated by coal, will be the most economical and convenient. This, of course, sets us free in the choice of the station—in itself a very considerable advantage, and if there is no strong reason on the ground of cost for land, or the like I should prefer the station marked No. 3 upon the plan, on the north side of the River Aire, at the end of Crown Point road. This site has the advantage of being the most central—a very important matter from the point of view of economy—and also the advantages that condensation water can be obtained for nothing, and that coal can be delivered by water cheaply.

The Power Required by the Cars.—What power is required for propelling the electric cars? Experience in this country and in the United States shows that, running at such a speed as you propose to run, a car can be propelled a mile with the expenditure of one Board of Trade electrical unit. In order to bring this in a shape more familiar to engineers, I should state that a Board of Trade unit is 1⅓ h.p. exerted for an hour. To put it another way, it is 2,640,000 foot-pounds. Hence, to run the whole 16 cars required on the tramway to be first laid down for one hour at seven miles an hour will require 112 Board of Trade units But whilst a Board of Trade unit is the amount of work required to run a car for a mile, this is very variable from time to time. When the cars are just starting, they require a very much greater current, and, of course, they require more when ascending a steep gradient. It may be taken, however, that the maximum power required by a car is more than three times the average power, or to put it another way, that whereas the average power required to propel a car is 9 h.p. to 10 h.p., the maximum power required in starting it on a gradient is 33 h.p. The effect of this great variation in the power on different parts of the tramway line is very important. Take any district, for example, in which the number of cars is few, say only three; it is quite possible—nay, certain, that occasionally all these three cars may be starting at one and the same time, demanding in that district the supply of 100 h.p. Suppose, on the other hand, that the number of cars in a limited distance is large, say 15 or 20, it is extremely improbable, one may almost say infinitely improbable, that all these cars will be starting at the same time, and hence, when the number of cars is great, the average power will differ less from the maximum power. But consider the application of this to a town such as Leeds, when the whole tramway system shall be developed in the centre of the town. The power required to propel the cars in the neighbourhood of Boar-lane will not differ greatly from constancy, but the power required on parts of the line remote from the centre of the town will vary very greatly; for example, the power in the neighbourhood of Roundhay Park, say, the last mile and a half of the road, will vary from nothing at all to 100 h.p, and the variations from nothing to 100 will occur with very great rapidity. But the duration, both of times of great demand and no demand, will be very short indeed. If the supply to the distant parts of the tramway system be effected solely by the agency of the central generating station, conductors will have to be provided of adequate size to carry, without undue loss of pressure, the whole 100 h.p.

The Value of Accumulators.—This can, however, be avoided by the proper application of accumulators. This application is precisely analogous to the familiar use of hydraulic accumulators for the hydraulic supply of power when the demand is variable. An accumulator would be placed in the neighbourhood of Roundhay, in any place which might be found convenient. This accumulator would be supplied with current from the generating station, the current being practically constant. Whenever the heavy drain of 100 h.p. in its neighbourhood was required, two-thirds of this power would be supplied by the accumulator, exactly in the same way as when many presses are required to work at once, the water is supplied to them from the hydraulic accumulators. The space required for such an accumulator would not be large; a room 20ft square would be sufficient if more were not available. A second accumulator would be placed towards the Kirkstall end of the line. It would be in all respects a duplicate of the accumulator at Roundhay. The accumulators would be worked under favourable conditions, as they would at all times be almost fully charged. Working under the less favourable conditions of electric lighting, accumulators can be maintained by contract with the manufacturers for less than 10 per cent. of their actual cost, and even at this rate it is more economical to maintain one's own accumulators if the management is reasonably careful. These batteries of accumulators would not require the constant attendance of a man; they would really work automatically, just as hydraulic accumulators do. They should, however, be frequently inspected. Accumulators have been used with very great advantage in the remarkably successful tramway from Douglas to Laxey in the Isle of Man, and under conditions analogous to those of Leeds. If the only question were that of the tramway from Kirkstall to Roundhay Park, I should recommend a third accumulator in the neighbourhood of the power station, because even there the variation in load would be very considerable. But one must look at the probable future development. When there are several tramlines all converging upon Boar-lane, the average effect of the larger number of cars will be felt, and the load will consequently vary very much less. There is another incidental advantage of the use of accumulators on the more distant portions of the line. It makes it much easier to conform to the Board of Trade regulations, which require that the difference of electrical pressure between the remotest parts of the line and the generating station shall not exceed 7½ volts. If accumulators are used it is only necessary to provide such return conductors, be they rails or be they specially

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provided, as will be sufficient to carry the average return current with less difference than 7½ volts. If, on the other hand, accumulators be not used it is necessary to provide conductors for the return of adequate size to carry the maximum current, which, as already stated, is three times as large as the average current. Another advantage in the moderate use of accumulators is that they provide the means of moving a few cars along the line or in the depôts even when the engines are standing. This would shorten to a certain extent the hours during which it would be necessary to run the generating machinery. I would have it understood, however, that though I am perfectly clear that accumulators will be a great advantage in working this tramway, I do not consider them by any means an absolute necessity. The line could be worked without them undoubtedly, but with less economy.

The Plant.—The next question to be considered is the size of unit to be used for generating the current. If there were no intention of extending the tramway I should recommend such a unit of power that two units would be capable of doing the work and would then put down an additional unit as spare, making three in all. But I must assume that we must provide for power at least four times as great as will be at first needed. Working as I have suggested, with accumulators, on the more distant parts of the line, 200 i.h.p. would be needed to propel the cars. If accumulators were not used, about 300 i.h.p. would be needed in order to ensure that the engine power should be adequate to meet the maximum probable demand. I should therefore propose, in the first instance, to put down two complete units of power, each capable of giving 200 h p.—that is to say, there would be two boilers, each of 200 h.p. or thereabouts, two engines, and two dynamos, each driven by its own engine. In the first instance, this would no doubt be a little more costly than putting down three units of power each of 100 h.p. But when the power is multiplied fourfold the advantages in favour of the larger unit will be great. We may then look forward to putting down six boilers, six engines, and six dynamos, each set capable of giving 200 h.p. Four of these would be in use at one time, and two would be spare—one ready for use, and the other, if necessary, undergoing examination or repair. The switchboards and instruments would be arranged, in the first instance, in such wise that they would be adaptable by additions and without alteration to the larger work. The buildings also should be constructed of adequate size in the first instance, or be so arranged that they would be readily enlarged. The cars should, I think, be electrically lighted by the same source of current as that supplied for propelling them. The lighting could not be expected to be absolutely free from variation of brilliancy, as to secure this would mean a considerable increase of cost. But it would be far better than any other artificial light available.

The Rails.—The question has been put to me by the city engineer as to whether, from a purely electrical point of view, the 70lb. rails would be of adequate section—that is to say, viewing them entirely as conductors, and apart from any question as to their being strong enough to mechanically carry the traffic. Seventy-pound rails would certainly be sufficient for the average current—that is to say, they would be sufficient if batteries were used. I think it would be worth while, however, for the committee to consider the possibility of an increased traffic, and an increase of the size of the cars, at some future time. In the event of either the traffic increasing or it being decided to omit the use of accumulators, 70lb. rails could still be used so far as the electrical conditions are concerned. It would be necessary to put in additional copper return conductors at an earlier time than would be necessary if the heavier rails were adopted.

The Capital Outlay—The schedule at the end of this report gives my estimate of the capital outlay for plant for the line from Roundhay Park to Kirkstall. It will be observed that this estimate does not include anything for buildings, as this will greatly depend upon the style in which they are done. It does not include the getting out and making good of the ground for laying the underground conductors, for poles, or for the bonding of rails It does not include the rails themselves, and it includes nothing for engineering expenses and contingencies. For this last item I should add 10 per cent. in order to be upon the safe side, although it is my experience that no addition to my estimates has been required for contingencies. It will also be observed that I assume it is necessary to treat the whole line as though there were no tramway already in Leeds. I have inspected the machinery at Burmantofts and the conductors already at work. I am of opinion that the engines and dynamos at Burmantofts will not be suitable for permanent use—the engine is not condensing, and it is not compound ; the dynamos are arranged to work 300 volts, instead of 500 ; and, lastly, the machinery would have to be removed in order to make it useful. But I think it is extremely probable that the overhead conductors might be usefully employed, at all events in the first instance. It is a little surprising how small a part of the whole expense of an electrical tramway consists in the actual providing of power. The cost of coal, oil, water, and wages at the generating station, other than wages for repairs, should be less than ½d. per car mile run, whereas the cost of wages of car driver and conductor will be more than 2d. per car mile run.

Summary.—I recommend that there should be a single generating station for the whole of Leeds ; that this station should be at the end of Crown Point-road, and hence that no attempt should be made to utilise the heat of the destructors. The station I should recommend would be one which could be developed by mere additions in such wise as to supply the whole of the current required for the completed scheme set forth in Mr. Hewson's report, or for any reasonably probable additions thereto. The indicated horse-power required for a 7½ minutes' service between Roundhay Park and Kirkstall would be 200. I should recommend that this be provided as a single engine, with another engine as a standby. The number of cars required would be 20—16 running and 4 spare. Each car would have two motors and the motors would be capable of developing together 33 h.p , but the average power required from the two would only be 10 horse. This assumes that the series-parallel control were adopted. This method is almost universally employed in the United States, and is used in a portion of the cars on the present Roundhay tramway. I am of opinion that trolley wires carried from central poles would be most convenient from the end of the present tramway to Kirkstall, and that probably the present conductor would serve for the rest of the route. The proper voltage to employ is the maximum which the Board of Trade sanction—namely, 500. By the ground being surcharged with electricity I understand is meant the possible effects of return currents. From this cause it is absolutely impossible that any effects to persons could result. I am also of opinion that no danger would result from the overhead wires, because these wires cannot be touched, and even if they were touched no serious consequences are to be apprehended. Electrolytic destruction of gas or water pipes would be rendered small by adhering to the Board of Trade regulations ; indeed, quite negligible by adopting a standard, as I would propose, even higher than is proposed by the Board of Trade. The working of telephones will probably be interfered with by the tramway, but the Legislature has put the onus of preventing such interference upon the Telephone Company, and not upon the tramways. If the Board of Trade regulations are carried out, there should be no interference with the telegraphs. A thoroughly effective electrical tramway could be laid with 70lb. rails. But if 70lb. rails were adopted it would be necessary, when the whole system is completed, to make use of a certain amount of copper conductor as an aid to the steel.

Schedule.	£	s.	d.
Trolley wire erected with insulators, 14 miles at £190	2,660	0	0
Poles for two trolleys, seven miles at £1,196 per mile	8 372	0	0
Bonding rails, at £150 per mile of single track	2,100	0	0
Seven miles of 0·15 square inch cable, at £317 per mile	2,219	0	0
Closed conduit for 310 yards of double rail, at £1 12s 6d. per switch	251	17	6
Twenty cars, at £750	15,000	0	0
Two boilers, each 200 h.p., with steam-pipes and economisers, at £700	1,400	0	0
Two condensing engines, at £1,400	2,800	0	0
Two dynamos, at £600	1 200	0	0
Switchboards and instruments	740	0	0
Two batteries, at £500 each	1,000	0	0
Instruments and switches, at £70 each station	140	0	0
Total	£37,882	17	6

DOVER ELECTRICITY SUPPLY COMPANY.

REPORT BY PROFS A. B. W. KENNEDY AND S. P. THOMPSON ON THE TESTS OF THE PLANT IN THE STATION.

The tests described in the following report had for their main object the determination of the capacity and efficiency of the plant supplied by the Brush Electrical Engineering Company, Limited, to the Dover Electricity Supply Company, Limited, under a memorandum of agreement and specifications dated November 20, 1892. The chief conditions in the specification affecting the capacity and efficiency of the plant were the following :

1. The output of the alternators to be 50 kilowatts, 75 kilowatts, and 100 kilowatts respectively, at an E.M F. of from 2,000 to 2,200 volts.

2. The output of each of the two exciters to be 12·4 kilowatts, or, say, 190 amperes at 65 volts.

3. The output of each of the two feed pumping engines to be equivalent to the full power of all the boilers.

4. The combined efficiency of the steam alternators to be 78 per cent. for the 50 and 75 kilowatt sets, and 80 per cent. for the 100 kilowatt set.

5 The steam consumption of the engines at full load not to exceed 19·5lb of water per indicated horse-power hour for the 50-kilowatt set, 19 0lb. for the 75 kilowatt set, and 18·5lb. for the 100-kilowatt set.

6. The energy absorbed in exciting the field magnets of the alternators not to exceed 2½ per cent. of the full output of the generators.

7. After a six hours' continuous run at full output, the temperature of no part of the armature or magnets is to exceed 60deg. F. above that of the atmosphere of the engine-house taken one minute after stopping the machine, on the side remote from the engine, and at no time to exceed 90deg. F. above the temperature of the atmosphere.

8. The insulation resistance between the whole of the conductors and the framework of the generator taken before and after a test at full load at any time not to be less than for the armatures 500,000 ohms, for the magnets 400,000 ohms, and the insulation of the armature to be capable of resisting a testing current at 4,500 volts alternating.

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9. The fall in potential on a non-inductive circuit between half-load and the maximum output, with constant speed and constant excitation not to exceed 150 volts.

10. Each of the main engines and alternators and the exciter engines and exciters to be subjected to a six hours' continuous trial at full load, and subsequently the two exciters to be tested in parallel with each other, and in all like manner all the alternators to be tested in parallel with each other, for two consecutive hours on from three-quarters to full load.

11. The circulating and feed pumps and engines connected with them to be tested at full working capacity for six consecutive hours.

The tests took place in the station at Dover on October 7, 8, 9, 10, and 11 last, and were carried out by ourselves and a special staff of trained observers whom we sent down to Dover for the purpose. The leading results of the experiments are set forth in the annexed tables; and on the whole matters referred to we have to add the following remarks, taking up the various points in the order in which they have been enumerated above:

1. No. 4 set was tested first at various loads, and, finally, during a continuous run of six hours at full power (50 amperes at 2,000 volts). The next morning the remaining machines were tested not only at full load, but at an output 20 per cent. in excess of full load. No. 3 set was run at 55 amperes and 2,200 volts for five hours and then at normal full load for another hour. No. 2 set was run at 39·5 amperes and 2 000 volts for five hours and then at 41 amperes and 2,200 volts for an hour. No. 1 set was run at 25 amperes and 2,000 volts for five hours and then at 27·5 amperes and 2,100 volts for an hour. Thus No. 1 machine was overloaded by 16 per cent., and Nos. 2 and 3 machines by about 20 per cent. All machines ran satisfactorily at these overloads as well as at their nominal maximum output. In every case the load was obtained by the use of tubs, so as to be strictly non inductive. The current was measured on Kelvin ampere-gauges, and the volts on Ayrton and Mather electrostatic voltmeters, in addition to the switch pillar instruments, and we believe that the measurements so made are for all practical purposes completely accurate.

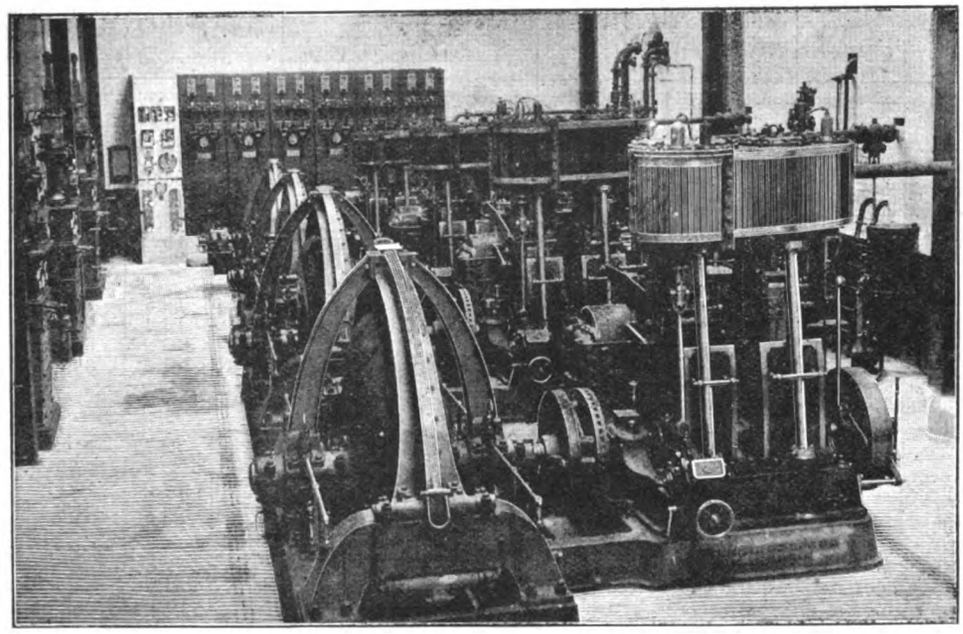
2. Each of the exciters was run on an external resistance at full load for about six hours, and gave its full output.

3. The feed pumping engines could not be tested to their full output, as we were unable to get more than enough work for one boiler. The maximum load which we were able to put upon any pump was between 7,500lb. and 8,000lb. of water delivered per hour. Each of the two pumps appeared able to furnish this delivery with ease.

4. The specified combined efficiency has been, on the whole, considerably exceeded. No. 1 gave 76·8 per cent. at full load and 80 per cent. at 17 per cent. overload. (In this case the machine was driving its own exciter, and the exciting watts are added to those of the alternator in computing the output and efficiency.) No. 2 gave 80·6 per cent. at full load and 81·0 per cent. at 20 per cent overload. Nos. 3 and 4 gave a mean of 81·1 per cent. at full load, and No. 3 gave 83·7 per cent. at 20 per cent. overload. Thus, although No. 1, the smallest set, has fallen very slightly short of the specified efficiency at nominal full load, it exceeded it when overloaded, and the other three sets have very considerably exceeded it, even at their nominal full loads, and we consider the results obtained in this matter highly satisfactory. In order to obtain the fullest information as to the efficiency of the machines, we indicated them not only at full load, but also at various smaller loads, as well as when running excited only. The detailed results of these tests are set forth in the tables. In all these experiments Crosby indicators were used, with tested springs, and the electrical instruments were read, the indicator diagrams taken and the revolutions noted simultaneously by separate observers. In the case of No. 1 machine, indicator diagrams were also taken at several different powers while running on the circuit in the evening. In this case the load was one which had considerable self induction, in consequence of the number of transformers on the circuit, and it was found that the apparent electrical horse-power (corresponding to the product of amperes and volts) exceeded the real electrical horse-power by about 13·5 per cent. over a range between 35 e.h p. and 60 e.h.p, the difference between the apparent and real output being, in fact, very nearly a constant percentage over this range. No doubt the difference will tend to diminish as the total load increases, as we believe that many more lamps can be served from each transformer than are at present connected up.

5. The steam consumption of the engines was measured by weighing the water passing away from their surface condensers. In the case of No. 1 set this amounted to 19·7lb. per indicated horse-power hour at full load, and 20·2lb. per indicated horse-power hour at 17 per cent. above full load. For No. 2 set the figures were 20 8lb. per indicated horse-power hour at full load, and 20·3lb. at 20 per cent. above full load. For No 3 set the figures were respectively 19·3lb. and 19 6lb, and for No. 4 set the consumption was 19lb. per indicated horse-power hour at full load. These figures are a little above those which have been guaranteed, but as the efficiencies of the machines are also above the guarantees, the consumption of steam per electrical horse-power hour, which is the really important matter, is practically the same as that corresponding to the specification. We therefore consider the results as to steam consumption to be quite satisfactory. We made consumption tests at various loads below full power, and the figures for these tests are given in the tables.

6. The measurements of magnetising energy were made by means of the station instruments in the switch pillar, which have been taken as correct for this purpose. A calibration made in the station after the tests showed that their errors were, at any rate, sufficiently small to be negligible. The percentage of magnetising energy to total output are shown in Tables II., III, IV., and V., from which it will be seen that they are (with the exception of No. II.) somewhat larger than the specified ratio of 2½ per cent.



View of Engine Room, Dover Electricity Works.

7. The temperatures of the alternators at the end of six hours' continuous full power run appeared to be in every case not only well within the specified limits, but quite exceptionally low. The two larger machines were practically cold after their six hours' full power run.

8. We regret that we were unable to make any measurement of the insulation resistance of the machine, as the testing set at the station was found to be out of order, but we have no reason to suppose that the insulation was not quite satisfactory.

9. Instead of measuring the fall of potential directly, we measured the excitation at constant speed and constant E M F., which gives the same proportionate result, and is more readily determined. The results are given in Table VI., and show that the variation differs greatly from 7½ per cent. (which corresponds to 150 volts in 2,000) in the different machines. In Nos. 1 and 4 it averages about 12 per cent., in Nos. 2 and 3 about 3·6 per cent. It is to be noted, however, that we could only measure the excitation at the terminals of the field resistances, and not at the terminals of the field windings themselves. This probably accounts for the obvious discrepancy of these figures. Within reasonable limits of variation, however, it does not appear to us that the constancy of excitation is a matter of any practical importance.

10. The full power runs of the main engines have already been mentioned. The engines, as well as the alternators, ran well, but it appeared to us that the consumption of lubricating material was somewhat unusually large. It may well be that this matter will rectify itself when the engines have run somewhat longer. No difficulty

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TABLE II.—Efficiency Tests of 50-Kilowatt Alternator with Brush Engine, being Set No. 1 in Station. October 9, 1895 (on tubs).

Nominal condition.	Number of sets of diagrams.	Mean pressure reduced to low-pressure piston	R.P.M.	I.H.P.	Primary.		Kilowatts self-excitation.	Total kilowatts.	E.H.P.	Efficiency per cent.	Exciting energy.	
					Amperes.	Volts.					Kilowatts.	Percentage of output.
Excited*	3	4·54	274	9·38	0	2,002	0	0	0	—	1 30	—
Quarter-load* ...	3	16·89	270·3	34·4	8 67	1,998	0	17 32	23·2	67·5	1·33	7·68
Half-load†	3	23 62	268 3	47·8	11 77	1,997·7	1·38	24·89	33·4	69 9	1·38	5·55
Full load†	7	44·42	269 4	90·2	25 1	1,994 7	1·58	51·65	69·3	76 8	1 58	3 06
Overload†	3	52·73	258	101·6	27·8 apparent	2,105 3	2 20	60·73	81 3	80 apparent	2·20	3·62
Oct. 7 (on circuit)												
—	1	43 0	274·5	44·5	13·3	2,010	0	26·7	35 8	80 4	—	—
—	1	43·6	273·5	44·9	13·7	2,010	0	27·5	36 9	82 1	—	—
—	1	50 4	273	51 8	15·8	1,995	0	31 5	42·2	81·4	—	—
—	1	51 7	273	53·2	16·4	1,992	0	32 7	43·8	82 3	—	—
—	1	59·1	275	61·3	19·1	2,000	0	38 2	51·2	83 5	—	—
—	1	59·9	275	62·1	19·4	2,010	0	39	52·3	84 2	—	—
—	1	66·9	271	68·4	21·5	2,005	0	43·1	57·8	84·5	—	—

* In these cases the excitation was derived from the separate exciters. † In these cases the machine drove its own exciter, the watts for which are therefore added in the column headed "Total kilowatts," and taken into account in calculating the efficiency.

TABLE III.—Efficiency Tests of 75-Kilowatt Alternator with Brush Engine, being Set No. 2 in Station.—Oct 9, 1895.

Nominal condition.	Number of sets of diagrams.	Mean pressure reduced to low-pressure piston.	R.P.M.	I.H.P.	Primary.		Kilowatts.	E.H.P.	Efficiency per cent.	Exciting energy.	
					Amperes.	Volts.				Kilowatts.	Percentage of output.
Excited	3	3·77	255	13·63	—	2,002	—	—	—	1·36	—
Quarter-load	3	13 47	249·2	47·59	12·33	1,997	24·63	33·01	69·36	1·39	5·64
Half-load	3	19 19	247·7	67·4	20	1,996·6	39·93	53·51	79·4	1·39	3·48
Three-quarter load... ...	3	28·43	247·2	99·63	29·5	2,000·6	59·03	79·13	79·4	1·37	2·34
Full load	7	36·67	254·7	132 5	39·5	2,017·4	59·7	106·8	80·6	1·44	1·81
Overload	3	41·19	255·2	149 1	40·9	2,203·7	90·11	120·8	81	1·61	1·79

TABLE IV.—Efficiency Tests of 100-Kilowatt Alternator with Brush Engine being Set No. 3 in Station.—Oct. 8, 1895.

Excited	3	3·42	235·7	16 04	0	2,005	—	—	—	2·36	—
Quarter-load	—	—	—	—	—	—	—	—	—	—	—
Half-load	3	20·4	230·3	93 54	26 03	2,000·7	52·08	69·8	74 6	2 57	4·94
Three-quarter load.....	3	27·09	231 7	124 9	36 7	2,008·3	73·4	98·4	78·8	2·58	3 52
Full load	3	34 99	236·7	164·6	49 77	1,997·7	99·4	133·2	80·92	2 67	2·69
Overload	3	41·63	233·9	193	54·88	2,197·9	120·6	161·6	83·7	3 19	2 64

TABLE V.—Efficiency Tests of 100-Kilowatt Alternator with Brush Engine, being Set No. 4 in Station.—Oct. 7, 1895.

Excited	4	3·73	236	17·52	—	1,995·25	—	—	—	2·24	—
Quarter-load	4	11·41	233·7	53·08	12·8	1,989	25·46	34·13	64·3	2·27	8 9
Half-load	4	23 01	232 2	106 4	30·92	2,001	61·84	82 9	77·9	2·42	3·91
Three-quarter load.....	4	29·32	232 5	135·7	40 07	1,996	79·99	107·2	79·1	2·56	3·20
Full load	6	35·39	234·2	165	50	2,000·6	100 03	134·1	81·3	2·74	2·74

was found in running the exciters in parallel. Alternators Nos. 1, 3, and 4 were run in parallel at different loads in accordance with the terms of the specification, and ran, in general, satisfactorily.

11. The circulating and feed pumping engines were run for much more than the specified period of six hours at as great a load as the conditions of station working allowed us to put on them. The feed pumps ran without the least trouble. The circulating pump engine did not run so satisfactorily; it seemed to be somewhat too small for its work.

We observe that in Nos. 3 and 4 machines a metallic shield has been inserted as a protection of the field winding from the armature coils. This is a very important improvement in the design of the alternators.

On the whole matter of the running plant in the station it gives us pleasure to say generally, in conclusion, that as to output, efficiency, and economy, as well as in respect to general construction, the results are very satisfactory, and are substantially in accordance with the conditions of the specification.

Table VI.—Variation of Excitation Between Half and Full Load.

Set.	Exciting energy—Half load.	Exciting energy—Full load	Variation per cent.
	Kilowatts.		
I.	1·38	1·58	12·6
II.	1·39	1·44	3·47
III.	2·57	2·67	3·75
IV.	2 42	2·74	11·7

COMPANIES' MEETINGS AND REPORTS.

DIRECT UNITED STATES CABLE COMPANY, LIMITED.

The report of this Company for the half-year ended December 31 states that the revenue, after deducting out-payments, amounted to £43,938, as compared with £38,342 for the corresponding period of 1894. The working and other expenses (including income tax, but exclusive of cost of repairs of cables) amounted to £19,058, leaving a balance of £24,880 as the net profit, making with the balance brought forward a total of £26,290. For the corresponding period the working expenses and other payments amounted to £19,024. Interim dividends of 2s. per share for the quarter ended September 30 and of 2s. per share for the quarter ended December 31 have been declared, and, after setting aside £10,000 to the reserve fund account, the balance of £4,148 on the revenue account has been carried forward. During the half-year repairs of the cables, including provision to December 31 for operations not yet fully completed, have cost £6,984, which has been debited to the reserve fund account as heretofore, the balance of which, with the addition of interest and the amount set aside from revenue account, now amounts to £306,005.

CITY AND SOUTH LONDON RAILWAY.

The accounts of the City and South London Railway Company for the half-year ended December 31 show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. preference shares, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1¼ per cent. per annum, carrying forward a balance of £1,220 to the new account. The dividend for the corresponding period last year was at the rate of 1¼ per cent. per annum, the balance carried forward being £950.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Alderman T. G. Gibson, J. P. (chairman), Dr. Robt. Spence Watson, Dr. J. T. Merz, Colonel F. F. Sheppee, J. Tennant, Esq., J. H Armstrong, Esq.

Report of the directors to the eighth general meeting of the shareholders:

The directors have pleasure in presenting the balance-sheet and profit and loss account for the year ending December 31, 1895, from which it will be seen that the demand for electricity has con-

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siderably improved during the past 12 months, the units sold having been 448,832 against 401,066 last year. The expenditure on capital account has been increased during the year by a portion of the cost of reconstructing one dynamo, so as to largely augment its output, and by the general extension of mains It has become necessary to extend the buildings, and additional plant has been ordered so as to meet the increasing demand for current. This will be fixed and in working order before the next winter's lighting season. To meet this expenditure a further issue of share capital has been made during the year, amounting to £6,725, of which a portion has been paid up and utilised in the extensions of the past year, and the remainder will be called up as required. The profit for the year is £2,909. 17s. 4d., as compared with £1,632 10s. in 1894. This profit is, however, chargeable with special adjustment of stock-taking and part of the expenditure on alterations to one of the dynamos, etc., amounting to £659. 6s. 5d., leaving a net balance of £2,250. 10s. 11d. Adding thereto the balance of profit brought forward from last year—viz., £288. 4s.—the total available profit is £2,538. 14s. 11d. Out of this the directors have transferred to reserve account a sum of £904. 3s. 7d., thereby increasing that account to £1,304. 3s. 7d., which they propose to use in further reducing the balance outstanding on the capital expenditure suspense account, so as to meet the views of the Board of Trade referred to in the directors' report for 1894. The capital expenditure suspense account will thus be reduced to £700, which which will be provided for out of the current year's profits. An interim dividend at the rate of 4 per cent. per annum was paid for the half-year ending June 30, 1895. The directors now recommend the payment of a dividend at the rate of 5 per cent. per annum, less income tax, for the half-year ending December 31, 1895. This will absorb £835. 3s., and leave a balance of £183. 18s. 11d. to be carried forward to next year's accounts. The retiring directors are Dr. R. Spence Watson and Mr. James Tennant, who are eligible and offer themselves for re-election. The auditor, Mr. Thomas Harrison, also retires, and is eligible for re-election.

BALANCE-SHEET, DECEMBER 31, 1895.

Capital and Liabilities.				£	s.	d.
Nominal capital—10,000 shares of £5 each				50,000	0	0
Issued and allotted—8,276 shares, with £4 per share called up	£33,104	0	0			
850 shares, with £2 per share called up	1,700	0	0			
	34,804	0	0			
Add calls paid in advance	3,741	0	0			
				38,545	0	0
Five per cent. mortgage debentures				20,000	0	0
Creditors—on sundry accounts				3,897	6	4
Reserve account—as at Dec. 31, 1894	1,400	0	0			
Added from 1895 profits	904	3	7			
	2,304	3	7			
Less transfer to capital expenditure suspense account as at Dec. 31, 1894	1,000	0	0			
				1,304	3	7
Profit and loss account—balance as per directors' report of Feb. 6, 1895	288	4	0			
Profit for year to date	2,250	10	11			
	2,538	14	11			
Less transfer to reserve account, £904. 3s. 7d.; and interim dividend at 4 per cent. per annum for half-year to June 30, 1895, £615. 9s. 5d.	1,519	13	0			
				1,019	1	11
				£64,765	11	10

Property and Assets.				£	s.	d.
Capital expenditure—						
Buildings and plant, as at Dec. 31, 1894	£41,787	5	0			
Additions to date	3,284	11	2			
				45,071	16	2
Meters, transformers, etc., as at Dec. 31, 1894	7,554	16	7			
Additions to date	1,532	5	8			
				9,087	2	3
Land purchased as at Dec. 31, 1893				1.639	10	0
Cost of provisional order as at Dec. 31, 1894				659	14	11
				56,458	3	4
Preliminary and formation expenses as at Dec. 31, 1894	1,123	12	10			
Preparatory and experimental work as at Dec. 31, 1894	1,880	10	9			
	3,004	3	7			
Less transfer from reserve account, as at Dec. 31, 1894	1,000	0	0			
				2,004	3	7
Loose plant and tools				454	14	7
Office furniture				115	3	5
Stocks at valuation				2,411	13	9
Debtors on current supply and for work done, etc.				2,953	13	7
Cash in bank and in hand				367	19	7
				£64,765	11	10

PROFIT AND LOSS ACCOUNT YEAR ENDING DEC. 31, 1895.

Dr.				£	s.	d.
Station charges—salaries, wages, coal, water, and maintenance				2,718	14	3
Street charges—salaries and maintenance				651	13	7
Rent, rates, taxes, and insurance				455	9	5
General charges—Directors' remuneration	£131	5	0			
Office salaries, legal and accountancy charges, stationery, stamps, telegrams, etc	632	3	5			
				763	8	5
Balance carried down				4,201	3	6
				£8,790	9	2
Adjustment of stocks, valuation, and special alteration to dynamo, etc				659	6	5
Interest—On debentures	1,000	0	0			
On calls paid in advance	172	14	3			
On deposits, etc.	118	11	11			
				1,291	6	2
Balance carried down				2,250	10	11
				£4,201	3	6

Cr.	£	s.	d.
Current supply—Household	7,415	10	9
Public lamps	574	1	11
	7,989	12	8
Apparatus rent	777	11	10
Profit on sale of lamps	22	4	8
Transfer fees	1	0	0
	£8,790	9	2
Balance brought down, being gross profit for year	£4,201	3	6

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Parma (Italy).—The municipal authorities of the city of Parma desire tenders by February 25 for the electric lighting of the city from June, 1897, to 1912.

Cattowitz.—Tenders are invited by January 29 for the supply of carbons for arc lamps at the railway. Particulars from the Königl. Eisenbahn-Direktion (Room 7 of the Administration Building), Cattowitz, for 50pfg. (6d.).

Aussig.—The communal authorities propose to have built a seven-mile single-line tramway. The choice of system is left open. Contractors are invited to place themselves in communication with the Stadtrath, Aussig-a.-d.-Elbe, Prussia. Tenders are to be in by January 31.

Swadlincote.—The Swadlincote Urban District Council intending to light the township of Stanton with electric lighting, invite tenders for the work. All particulars can be obtained from Mr. R. Cartwright, surveyor, Swadlincote, to whom tenders must be sent by 27th inst.

Chester.—Messrs. Thos. Parker, Limited, electrical engineers, Wolverhampton, request firms who are willing to tender for the buildings required for the electric lighting station in Chester to send in their names to Messrs. J. H. Davies and Sons, architects, 24, Newgate-street, Chester.

Wigan.—The Corporation invite tenders for the erection of a dynamo-house and boiler-house for the generating station of the proposed Corporation electric lighting works, for the Gas and Electric Lighting Committee. Drawings may be inspected, and copy of specification, conditions of contract, and bills of quantities obtained, on depositing £2. 2s., which will be returned on receipt of a bona fide tender, on application to Mr. Jos. Timmins, engineer, Wigan. Tenders, sealed and endorsed "Dynamo-House, etc.," to be addressed and delivered to Mr. J. J. Charnock, town clerk, by 20th inst.

Birkenhead.—The Corporation invite tenders for the wiring of the town hall in order to light the same by electricity. Plans can be seen on and after 15th inst., and a copy of the general conditions and specification, with form of tender, can be obtained on payment of £1. 1s. (to be returned on receipt by the Corporation of a bona fide tender) at the town clerk's office, Town Hall, Birkenhead, or at the office of Mr. James N. Shoolbred, M.I.C.E., 47, Victoria-street, London, S.W. Tenders, which must be on the prescribed form, sealed, and endorsed "Tender for Electrical Wiring, Town Hall," must reach Mr. Alfred Gill, town clerk, Town Hall, Birkenhead, by 12 noon on 23rd inst.

Shoreditch (London).—Tenders are invited for the supply and erection of buildings, including an engine-house, offices, and building enclosing dust destructor (the dust destructor being included under another contract), for the Vestry of St. Leonard, Shoreditch. Specifications, bills of quantities, and forms of tender, and any additional information can be obtained from the engineers, Messrs. Kincaid, Waller, and Manville, of 29, Great George-street, Westminster, S.W., on payment of £3. 3s., which sum will be returned when a bona fide tender is received by the Vestry. The plans can also be inspected by intending contractors at the offices of the

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engineers. Sealed tenders shall be sent to Mr M. Mansfield Robinson, Shoreditch Town Hall, Old-street, E C., endorsed "Electric Light Station, Tender for Buildings," at or before noon on 20th inst. The contractor whose tender is accepted shall enter into a formal contract under seal with sufficient sureties for the fulfilment of contract.

RESULTS OF TENDERS.

New Mar (N.B.).—The tender of Messrs. P. C. Middleton and Co. for lighting and heating Mar Lodge by electricity for £3,000 has been accepted.

BUSINESS NOTES.

Neston.—The District Council have postponed the question of lighting the district by electricity.

Western and Brazilian Telegraph Company.—The receipts of this Company for the past week were £2,664.

Dover.—The electric light company are about to lay mains in Worthington-lane, York-street, and Priory-street.

Birkenhead.—The Town Council are lighting the town hall with electricity; the total cost is estimated at £1,500.

Monmouth.—The plans and specifications of the electric lighting scheme have been sent to the Board of Trade for approval.

Aberdeen.—The Lighting Committee have decided to erect about 230 additional lamps in the streets at a cost of about £4,000.

Kirkcaldy.—The Town Council have appointed a committee to consider the question of introducing the electric light into the town.

Minster.—The Isle of Thanet Rural District Council are making enquiries as to the cost of lighting the union workhouse by electricity.

Telephone Extension in Cornwall.—Active steps are being taken to obtain an extension of the Government telephone trunk line to Penzance.

Newport (Mon.).—The Town Council have decided to borrow £12,000 additional capital for extension of electrical plant, etc., making £40,000 in all.

Appointment.—Mr. J. F. Poynter, of 15, Seething-lane, E.C., has been appointed sales representative of the Cruto Incandescent Lamp Agency, Limited.

Bath.—It appears from the report of the Municipal Buildings Committee to the Town Council that the cost of the electric lighting installation was £786.

Ilfracombe.—The gas company's new Bill proposes to enable the company to apply for a provisional order to supply electricity within the limits of their gas supply.

Watford—The Urban District Council have unanimously resolved to appoint a committee to consider the advisability and practicability of lighting Watford by electricity.

New Cables.—The treaty of commerce between Chili and Brazil has been signed by the Presidents of the two Republics, and a cable is to be laid between Valparaiso and Punta Arenas.

Lighthouse Communication.—Maplin Lighthouse has just been connected by telephone cable across the sands 15 miles to Southend Coastguard Station for coast defensive purposes.

City and South London Railway.—The returns for the week ended January 12 were £1,020, compared with £1,001 for the corresponding period of last year, being an increase of £19.

Kingswood.—The Urban District Council have passed a resolution approving of the tramways company applying for an order legalising the late extension from the King's Arms to Warmley Hill.

Perth.—A committee has been appointed to consult with an expert as to what extent the lade power in the control of the Corporation could be used to light the Corporation buildings with electricity.

Train Intercommunication.—The agent of the South Indian Railway has obtained the sanction of Government for the introduction of Mr. Winter's electric system of train intercommunication on that line.

Pembroke.—It is stated that the old works of the Milford Haven Shipbuilding and Engineering Company at Jacob's Pill, Pembroke Dock, have been taken by a firm of electrical engineers, and will be opened shortly.

New Companies.—During the past year 3,540 new electric companies were formed, with a capital of £2,773,100, as compared with 2,668 companies (£2,387,107 capital) in 1894, and 2,333 companies £2,045,500) in 1893.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending January 12 amounted to £1,120, as compared with £866 in the corresponding week of the previous year, being an increase of £254.

Sheffield.—A sub-committee of the City Council has been appointed to confer with the promoters of the Sheffield District and Rotherham Tramways Bill as to the provisions of the Bill, and report to a future meeting of the Parliamentary Committee.

La Compagnie Urbaine.—A general meeting of La Compagnie Urbaine d'Eau et d'Electricité has decided on an increase of the capital from 300,000fr. to 700,000fr. It is believed to be the intention of the Company to buy up a large number of smaller undertakings in France.

Cork.—Messrs. J. Furlong and Sons have offered to supply the electric current for one month free of charge at the South Jetties, for the purpose of lighting the place, as an experiment. The Harbour Board have accepted the offer, and passed a vote of thanks to Messrs Furlong

The Dangerous Trades Committee.—Commander Smith, R.E., Heatherley, Sheffield (secretary of Mr. Tennant's committee for enquiring into dangerous trades), will be glad to have the names tendered of persons desiring to give evidence with reference to electric generating works, etc

Bristol.—The Electrical Committee have decided to obtain an additional alternator, in order to efficiently meet the increasing demand for light, and to extend the mains from St. Stephen-street along Quay-street to Nelson-street. During the last month 1,400 new lamps were supplied with electricity for private consumers.

Ballochmyle (Ayr).—The sandstone quarries have been lighted by electricity to allow of work being carried on day and night. The order for plant and machinery was placed with Messrs. Paterson and Cooper, of London and Glasgow, and erected under the superintendence of Mr. E. George Tidd, M.I.E.E., A.M.I.C.E.

Yarmouth.—The borough surveyor's report on electric lighting states that the income for the year had been £1,942, leaving £463 towards repayment of capital, interest, depreciation, rates, and taxes, which he estimates would be about £900. The cost of the installation to the ratepayers in this the first year of working has thus been about £450.

Fermoy (Ireland).—The Town Commissioners recently advertised for tenders for lighting the district by electricity, but they received no replies. Mr. Warden Stevenson, electrical engineer, has written to them attributing that to the fact that it had not been mentioned in the advertisements that all information could be obtained at his office. It has now been decided to use incandescent gas-burners.

Bangor (N. Wales)—The City Council have decided to provide an electric lighting plant for the borough at a cost of £13,000. The British Insulated Wire Company, Limited, and the Manchester Edison-Swan Company, Limited, wrote offering to purchase the rights of the Council for generating and supplying electric energy, but the Council have replied that they have no intention at present of disposing of their rights.

Dublin.—The Corporation and the Dalkey Township Commissioners have decided to oppose the Dublin Southern District Tramway Company's Bill in Parliament. A long statement has been published by the managing director of the company to show that the extension of the lines into unoccupied parts of the city, and the introduction of the overhead system of electric traction, will be of great advantage to the town of Dalkey and the city of Dublin.

Tanfield (Durham).—The District Council are proceeding with the lighting of the district. Sixteen lamps have been erected at Hobson Colliery, and on Monday night the village of Tanfield was lighted. The contractors for the lamps were Messrs. T. A. Moffit and Co., Gateshead, who have been entrusted with the most of the lighting in the neighbourhood, and it was carried out under the superintendence of Mr. R. Heslop, surveyor to the District Council.

Birmingham.—A memorial signed by 6,300 people in Nechells has been presented to the City Council in support of the application of the Central Tramways Company for permission to adopt the overhead electric system on the Nechells route. Four memorials against the proposal were also presented. The first bore 727 signatures, the second 792, the third 1,063, and the fourth 975. The memorials were referred to the Public Works Committee.

Glasgow.—The Tramways Committee report that the electric light in the cars has been, for the time being, a failure. The contract with Froggatt's Electric Lighting Company had not been very satisfactory, and they had just received intimation that the company, who were the contractors for the lighting of the cars by electricity, were now in liquidation. The committee will now consider the propriety of having an electric light installation of their own for the cars.

Shoreditch (London).—The Electric Light Committee of the Vestry have had under consideration the question of entering into a contract to supply the London, Walthamstow, and Epping Forest Railway Company with electricity for lighting their stations and tunnels. The company would require about 420,000 Board of Trade units per annum. It was decided to enter into a contract with the company, whose trains, however, will not be running for another two years.

Worcester.—The quantity of water pumped by the electrical motors at the waterworks for the quarter ended September 29 was 15,237,500 gallons at a cost of £106. 19s. 8d. It was stated at the City Council meeting that the cost of pumping by steam power would have been about one-half that sum, but it was pointed out that last year was the driest year they had had for 81 years, and two turbines had been out of order for at least six months of the year.

Portsmouth.—The Provincial Tramways Company are promoting a Bill in Parliament for power to establish an electric tramway system. The project meets with the approval of the Corporation, and one object of the company in seeking this power is to meet the Corporation in their endeavour to utilise the current which now runs to waste at their electric light generating station. The company are also applying for power to erect generating stations of their own.

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Gas in the City of London.—A deputation from merchants in Lime-street, headed by Mr. Thomas Christy, attended a meeting of the City Commissioners of Sewers, and drew the notice of the Commission to recent alarming gas explosions there. Such was the inconvenience created by these mishaps that, for fear of explosion, the inhabitants had not dared to light a match, or a candle, or their gas-burners for a week. The matter was referred to the Streets Committee for instant investigation.

The Electric Light in Hyde Park.—We are informed that, by order of the First Commissioner of her Majesty's Works, etc., an arc electric light has been placed experimentally opposite to the Marble Arch within the park. This has been done after consultation with the police authorities. Should the light prove a success it is proposed to light with similar lamps the footpath between the Marble Arch and Albert-gate, a much-frequented route, and also to place another row of lamps round the bandstand for use during the summer months.

West Riding.—The joint committee have had under consideration the question of a private service of telphones for the purposes of the West Riding Constabulary, and have instructed the West Riding solicitor to prepare an agreement with the National Telephone Company, Limited, embodying terms which include the payment of an annual sum of £1,300 by the County Council, the Telephone Company providing telephone communication for the West Riding police and sectional stations, to be connected by telephone with the headquarters at Wakefield.

Southport—The loss to the borough on last year's electric lighting is about £210. In making the installation the sum of £39,550 was spent upon private lighting, and £2,581 for the lighting of Lord-street and the promenade. There remains an unexpended balance of £691 upon the present borrowing powers, and it is intended to apply to the Local Government Board for power to borrow another £4,000 to light London street and Chapel-street by electricity at an estimated cost of £90 per annum. It is believed that in a short time the installation will pay its way.

Wimborne.—The Urban District Council have received a letter from the solicitors and agents of the Pokesdown Urban District Council as to opposing the Bournemouth Gas and Water Company's Bill in Parliament, it being pointed out that the company would acquire powers to supply gas, water, and electric light to the exclusion of the local authority. It was stated that the Pokesdown Council contemplated opposing the Bill, and as the Wimborne Council were affected in the same way, the solicitors asked if they would join with them. The matter has been referred to committee.

Ambleside.—The Electric Lighting Committee have intimated to the District Council that they have had under their consideration the application by the Windermere and District Electric Supply Company, Limited, for a provisional order authorising them to supply electric light within the district. The committee have conferred with the Board of Trade upon the subject, and have received an intimation that if they wish successfully to oppose the granting of the provisional order, it will be necessary for the Council themselves to apply for a similar order within a reasonable time.

Bradford.—The Gas and Electricity Supply Committee recommend the provision of additional engines and plant at an estimated cost of £11,000. The scheme of extension is expected to cost altogether a sum of £30,000. The plant will be of the best description and as a beginning two engines of 600 h.p. each and two dynamos will be fixed It is intended to put the Corporation in a position to supply electricity not only for lighting purposes, but for motor purposes. The charge for electricity for motive power is fixed at 3½d. per unit, and for electricity for lighting at 5d. per unit.

Birmingham.—Messrs. Lane and Martineau had given notice that they intended to propose resolutions at the Town Council with reference to the transit of mechanically-propelled vehicles along the public roads. Mr. Lane, however, withdrew his resolution in favour of Mr. Martineau's, which was as follows: "That a memorial to the Board of Trade be prepared and signed by the Mayor, in the name and on behalf of this Council, praying that a Bill may be brought in to relax the restrictions which now hamper the transit of mechanically-propelled vehicles along the public roads" The resolution was seconded by several members, and unanimously carried.

Messrs. Bennett and Druce.—This firm report from 30, Winckley-square, Preston, a moderately busy year, but the outlook is a good one. Some of their more important installations during the year have been St. Joseph's Catholic Church, Preston (battery and gas-engine installation); an installation of 600 incandescents and arc lights combined for the new sheds at the Salford Docks; the lighting of the late Colonel Ormrod's mansion at Scorton (steam and battery plant); the fixing of two electric motors for printing the *Preston Herald*; a 10-h.p. hoist for the Preston Industrial Co-operative Society, Limited; and also an electric heating and ventilating system for the same society.

Newington (London).—A petition is being signed in Newington, to be presented to the Board of Trade, in opposition to the Vestry's proposal to obtain a provisional order for electric lighting purposes. The petition points out that the parish mainly consists of small tenement and dwelling houses inhabited by two and more families; that there are no factories in the parish which would be likely to require electricity; and that there are but few main thoroughfares in the parish, and these of a character where electric light would not be needed by the tradesmen. These and other reasons are set forward, and the petitioners ask the Board of Trade to refuse their sanction to the order.

Aberdeen.—The Great North of Scotland Railway Company have decided on experimenting with the electric light for the illumination of their carriages on the system of Messrs. J. Stone and Co., Deptford, which has already been adopted by several of the English and Irish companies. At first the experiment will be confined to seven carriages comprising the suburban trains from the city to Dyce. Messrs P. C. Middleton and Co., electrical engineers, have received the contract for the lighting and heating of Mar Lodge by electricity. The electricity will be generated by water power on the estate, and the cost of the work is estimated at between £2,000 and £3,000

Hanley.—The Local Government Board have sanctioned the borrowing by the Council of the sum of £19,000 for the purposes of electric lighting. The Council have made a reduction in the charge for electric current. They have also resolved that a representation be made to the Board of Trade objecting to the North Staffordshire Tramways Company obtaining power to supply electrical energy for private purposes within the borough without the consent of the Council. The managing director of the company (Mr. Carruthers Wain) has written to say that this proposal of the company did not apply to Hanley, but to the other towns in which the authorities did not provide electrical power.

Eccles.—The Town Council have issued a statement on the subject of electric lighting to the ratepayers. The Town Council have received a letter from the Town and Village Electric Light and Power Company, Limited, stating that the company were prepared to erect on land owned by the Corporation a complete installation for public lighting by electricity, and to lay mains for private lighting on terms of an annual payment extending from 20 to 40 years, bearing interest at 3 per cent, so that the Corporation would, at the end of the term, acquire the whole property in an electric lighting installation in complete working order, as the company would maintain the installation, do the repairs, and effect the renewals by agreement.

Fareham.—In reference to the purchase of the electric light works, in accordance with the result of the poll of the ratepayers, the clerk has informed the Urban District Council that in accordance with instructions he had written to Mr. Whitlock, solicitor to the electric light company, to the effect that the Council accepted the offer of the company made in court to carry out their contract of August 16, 1894, in lieu of the payment of damages, and the company had replied offering to send a draft agreement, and to consent to a stay of execution of their judgment obtained against the Council. After discussion, it was decided that the matter should be deferred until the Council obtained a further report from their solicitors.

Ashton-under-Lyne.—The Electric Lighting Committee have ordered enquiries to be made by advertisement and circular as to the probable demand in the event of their carrying out the Electric Lighting Order of 1882. The sub-committee of the Highways and Tramways Committee reported that after a conference with neighbouring local authorities it was decided that the authorities should place themselves in a position to oppose the application of the British Electric Traction (Pioneer) Company, Limited, for powers to construct electric tramways from Oldham, through Ashton and Audenshaw, to Denton and Hyde, if such opposition should hereafter be found to be desirable, and the town clerk was instructed to take such steps as might be necessary for this purpose.

Halifax.—The Tramways Committee of the Town Council have decided to recommend the Corporation to approve of the Bill promoted by the Halifax and District Tramways Company, Limited, on condition that clauses are inserted for the protection of the Town Council with regard to gas and water pipes, electric mains and sewers. In their resolution the committee also suggest that the period for compulsory purchase of the tramways by the Corporation be reduced from 28 to 21 years, the term prescribed by the Tramways Act of 1870, in the event of the company's receipts showing an average dividend for the 21 years of 7½ per cent. The Sowerby Bridge District Council also, to whose district the proposed line of the company is to extend, have passed a unanimous resolution approving of the scheme.

Appointments Vacant.—The Lighting Committee of the Wolverhampton Town Council invite applications for the post of assistant and draughtsman to the borough electrical engineer at a salary commencing at £100 per annum. Candidates must have had training in mechanical and electrical engineering and be competent draughtsmen. Applications, to be made upon forms to be obtained from Mr. F. Harman Lewis, borough electrical engineer, Town Hall, Wolverhampton, to whom they are to be returned, duly filled in, with copies of testimonials attached, by 23rd inst.—The Government of Queensland, Australia, are prepared to receive applications for the post of electrical engineer to the Government at a salary of £600 per annum. Full particulars can be seen in our advertisement columns.

Witton Gilbert (Durham).—The lighting of the streets and roads of Witton Gilbert by electricity was formally inaugurated on Saturday. This installation has been erected by the Corlett Electrical Engineering Company, Limited, of Newcastle, Wigan, and Lancaster A coupled high speed vertical engine by Ruston, Proctor, and Co, Limited, Lincoln, drives a Crompton 250-volt dynamo which supplies current to about 180 16 c.p. lamps distributed over about 10 miles of wire, the furthest light being over two miles from the dynamo. The light having been switched on by Mr. Brass chairman of the Witton Gilbert Council, the whole body of councillors drove over the district and inspected the light, which gave great satisfaction, it being as bright and powerful at the most distant lamp as it was near the dynamo.

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Copper.—The latest mail reports from America estimate that the consumption of copper has inproved at least 25 per cent. or more the past year than for 1894 Notwithstanding production increased and exports decreased, tabulated, yet the consumptive demand improved to such an extent as to absorb the increased surplus. Besides this a large amount of copper exported from this country during the year was reshipped back again for use here. It is confidently expected that the demand will greatly increase in the ensuing year, in anticipation of a largely increased demand for electrical purposes, as well as for general use The average price of Lake ingot copper at New York during 1895 was 10·77 cents per pound, while the average price of spot G.M.B. copper in London for the same period was £40. 7s. 4d. per ton.

Electric Lighting in the Metropolis.—The establishment of public electricity supply works in the metropolitan districts is a question that is now being prominently pressed forward by the various local authorities. Works are in operation at St. Pancras, Hampstead, and Ealing, and the Islington Vestry works are announced to be ready for opening on March 4. The Battersea Vestry have taken the novel course of offering premiums to consulting engineers and contractors for the best schemes, reports, designs, plans, and estimates for lighting the parish. the schemes to be submitted to an engineer of eminence for an independent report. In response to the invitation 21 schemes have been sent in, and they are now under the examination of Mr. Robert Hammond, M.I E.E., of London, who has been appointed the Vestry's electrical adviser on the subject.

Calendars.—We have received a well-designed calendar from Messrs. Ernest Scott and Mountain, Limited, electrical and general engineers and founders, of Newcastle-on-Tyne. The Sandycroft Foundry and Engine Works Company, Limited, have sent us their large office calendar. The sheet for each month contains a couple of illustrations of their manufactures; for instance, an electromotor driving a pump and an electric locomotive. From Messrs. Engelbert and Co, lubricating oil manufacturers, comes a large office calendar printed in colours. The feature of it is that each sheet contains the calendar for the month and also the year, so that back dates can be recovered after the sheets referring to the past months have been torn off. There has also to be acknowledged from the Chloride Electrical Storage Syndicate 16, Victoria-street, S W., a small waistcoat-pocket memorandum book. This is in addition to the annual pocket catalogue, and, like it, is a neat little book bound in red morocco

Ipswich.—On the report of the special committee on electric lighting coming up for discussion, the Town Council decided to withhold assent to the application for a provisional order by the County of London and Brush Provincial Electric Lighting Company. The decision practically stands by itself, and settles nothing, except that this particular order shall not receive the sanction of the Corporation. Beyond this everything is left open The committee appointed to consider the matter have been empowered to again consult Prof. Kennedy, and so far as the character of their report goes, they will have a free hand. About five years ago the Town Council decided that it would be best for the town to let some private company undertake the work, and they allowed a company to apply for a provisional order, and a fortnight after they allowed another company to do the same But this policy has now been reversed so far as the committee's report is concerned The number of private installations existing in the town may be taken as an indication that there is a real demand for electric lighting.

Derby.—The Bill to incorporate a company for the construction of tramways from Derby to Ashbourne has been deposited for next session. The Bill proposes to confer powers to construct a practically single line of tramway, commencing by a junction with the existing lines of the Derby Tramways Company in Ashbourne-road, Derby, and terminating in Ashbourne at a point near Compton Bridge. The capital proposed to be raised by the company is £70,000, divided into 7,000 shares of £10 each. Borrowing powers are also sought to be exercised by mortgages upon the undertaking to an extent not exceeding £17,500. By Clause 81 of the Bill it is provided that the cars shall be "moved by animal power," but every provision is made in the Bill to obtain the consent of the Board of Trade to the use of the "overhead trolley system of electrical traction," or some other mechanical power In addition to the carriage of passengers, the Bill provided for the carriage of animals and goods. The time sought for the construction of this tramway is five years from the passing of the Act, during which period it is proposed to pay interest out of capital to an extent not exceeding £10,000.

Swansea.—The Town Council have passed the formal resolution authorising the electric lighting and tramway scheme. In moving the resolution the Mayor (Mr. Bradford) said it would be remembered that the Council in committee had decided to call in independent expert evidence on the electrical scheme of Mr Manville, and he (the mayor) had since seen in London Mr W. H. Preece, electrician to her Majesty's Government in the Postal Department, and that gentleman had consented to examine and report thoroughly on Mr. Manville's plans and advise the Corporation thereon. Mr. Preece was one of the most eminent electricians of the day, and, although entitled to large fees, had kindly consented, under the circumstances, to accept only 100 guineas for his services, and he (the mayor) felt sure the matter could be safely left in his hands. Mr. G. Ellis, chairman of the Portsmouth Corporation Electric Lighting Committee, has written to the *South Wales Daily News* in reference to statements made by the opponents of the Swansea scheme that the cost of production of electricity in an ordinary electrical station with a lighting load only is 4d. per unit. At Portsmouth, Mr. Ellis remarks, the costs of production, inclusive of everything, are only 2¼d. per unit, whilst at Swansea, assuming that electricity was to be applied for lighting only, the cost would be slightly less, as coal is cheaper and of better quality.

Brighton.—Mr. Arthur Wright, the borough electrical engineer, suggests an extension of the electric lighting in the streets of 10 sets each of five seven-ampere lamps, such as are now being erected in the principal streets. The average distance apart will be about 70 yards. For the better lighting of the remaining streets he urges the committee to instal incandescent lamps in all the street lanterns that are in proximity to the distributing mains, his chief reasons being that the increased illumination of the streets can be more economically effected by using electricity than by increasing the consumption of gas, and that a profit of about £1,200 per annum would accrue to the Corporation by the electricity undertaking supplying the necessary current on the present tariff. The number of street standards affected by the proposed change of illuminant is at present 589. Mr. Wright estimates the capital required on district fund account at £4,300, and the capital required on electricity works account at £4,100. The Lighting Committee recommend that he be instructed to prepare specifications upon which tenders may be invited for carrying out the several works by contract. The committee further recommend that application be made to the Local Government Board for their sanction to the borrowing of the necessary capital. An installation is being fitted at 142, Marine parade, under the superintendence of Mr. W. Perren Maycock, M I E.E.

Edinburgh.—Mr. Mackenzie, convener of the Electric Lighting Committee, stated at the Council meeting that he had a report from the resident engineer showing that up to December 26 the units sold were 459,282, representing an increase of 73,282 units and £1,400 or £1,500 in money more than was expected a few weeks ago. With regard to a request by the treasurer, he could give an estimate of the cost of public lighting for next year on the number of lamps—250—sanctioned by the Council. Assuming that those lamps were all lighted for a year at the £18 rate proposed, the charge upon the Lighting Committee would amount to £4,500. They calculated that a capital expenditure of £12,500 had been incurred for the public lighting. The interest on that sum came to £375, or £1. 10s. per lamp; the sinking fund to £416. 13s. 4d., or £1. 13s. 4d. per lamp; the cost of carbons to £425, or £1. 14s. per lamp; the trimming to £750, or £3 per lamp; and the upkeep to £120, or 9s. 7d. per lamp. That left £2,413. 6s. 8d. or £9. 13s. 1d. per lamp for the current, and that meant that for the 480,000 units which they had to generate to keep the 250 lamps going for one year, they got about 1¼d. per unit. The Electric Lighting Committee have resolved to invite quotations from leading manufacturers for 10 000 high-voltage lamps, in view of the inauguration of the contemplated changes throughout the low-tension system from a voltage of 115 to one of 230.

Kidderminster.—The Kidderminster and Stourport Electric Tramway Bill has been deposited for next session. Upon this company power is proposed to be conferred to construct an electric tramway three miles six furlongs six chains in length, commencing opposite the Town Hall-buildings, Kidderminster, passing thence to Bridge-street, Stourport, opposite the north-eastern corner of the Bridge Inn. From this tramway two branch lines will run, one five furlongs in length, and the second four lengths seventy-one chains in length. In connection with these lines it is proposed to widen the two bridges which will be passed over in New-road, the two bridges which will be crossed in Stourport-road, together with a widening of that road on its western side. The period sought for the completion of these tramways is two years from the passing of the Act, or two years from the completion of any bridge or road widenings in the case of those lines dependent on the widenings. The capital of the company is fixed by the Bill at £60,000, divided into 6,000 shares of £10 each. The borrowing powers of the company are limited to £15,000, but it is expressly enacted that the company "shall not create debenture stock." The gauge of the tramways is to be 3ft. 6in., and, although the Bill contains a clause fixing the maximum rates for the carriage of goods, animals, and small packages, it is provided that the company shall not be bound to carry them between 8 o'clock in the morning and 8 o'clock in the evening.

Leeds.—The members of the Leeds Tramways Committee, accompanied by the city engineer (Mr. Hewson) have inspected a section of Mr. Chris Anderson's patent enclosed electrical conduit, which has been laid down for experimental purposes at Thwaite-gate, Hunslet. In this system the motors in the cars are fed from an underground conduit. Along the track, 21ft apart from each other, are iron boxes, the lids of which are level with the road. In each box are three pins, about an inch in diameter. These pins, by an ingenious mechanical arrangement, are made to rise about 3in. above the road as the car passes along the track. These small projections convey the current from the conduit to a collecting bar at the bottom of the car. At the end of the collecting bar is a ramp, or, in other words, the bar turns slightly downwards, and as the car passes over the ramp knocks down the pins to the level of the road again, and the current from that particular box is at once automatically switched off. The knocking down of these pins sends up the pins in the next box, which is then under the collecting bar right in front of the car. In the complete working of this system the current, after passing through the motors, is returned through the rails of the track. He estimates the cost of constructing his patent conduit at £1,200 per mile The committee have not yet come to a decision respecting this scheme. They were very favourably impressed with the Westinghouse electro-magnet system, of which they have seen a large working model at

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Westminster, and they have resolved to recommend it to the Highways Committee.

Lambeth (London).—The Vestry have received a report from their clerk (Mr. H. J. Smith) that the London and Provincial Brush Electric Lighting Company had lodged a formal application for a provisional order for lighting the whole of the parish, as well as Newington, Camberwell, Battersea, and the district of St. Saviour's Board of Works. The order contained the usual provisions and provided for no limit of time, so that it would therefore be permanent subject to the power given by the Act of 1888 to the Vestry to purchase the undertaking at the end of the various periods set forth. As notice of objection must be lodged at once, the Vestry were advised to promise the Board of Trade to take up the order and begin work at once, or allow the company a free hand. Mr. Sydney Morse, on behalf of the Brush Company. wrote pointing out that his company were the undertakers in Wandsworth, and had a capital of £800,000. Mr. C. W. Sax, of 366, Central Markets, West Smithfield, wrote that he was prepared to take over the obligations of the order, and Mr. Stewart Bain, on behalf of the London Electric Supply Corporation, wrote requesting the Vestry not to assent to any application from another company. After a long and at times somewhat lively discussion, during which a motion and amendment were rejected, the Vestry decided to instruct the clerk to lodge an objection to the granting of any order to the company except on the condition that the order should not now apply to any of the areas now covered by electric lighting companies; that the time for compulsory purchase be made concurrent with that of the London Company; that the cost of light per unit should not exceed 6d.; that the company pay the Vestry £1 000 to cover the initial expenses incurred by them in obtaining their order in 1892; that the clerk should be instructed to oppose any order for the parish until the Vestry had decided to accept or refuse the offer of Mr. Sax or any other company who may offer within a month to take a transfer of the Vestry's order.

Plymouth.—The Electricity Sub-Committee have made the following suggestions to the Town Council: "That the Council should itself put in force the powers it has obtained for supplying electricity within the borough, and that the central station should be on the shores of the Cattewater, and should be so designed that the waste heat from a destructor may be utilised if hereafter found desirable or feasible, and that electricity for traction purposes should be supplied from the same station." They further recommended: "That an engineer should be appointed at a salary of £300 per annum, rising by four equal annual increments to £400 per annum, and that in this way the conmissions usually paid during construction should be saved, and the services of a competent man fully conversant with every detail of the undertaking and practically interested in it secured. That the Corporation should not tie itself at this stage to any consulting engineer, nor to any manufacturer, type of engine, or plant. That public lighting of the Hoe, the principal places of resort, and streets should be at once undertaken; and that, immediately upon his appointment, the electrical engineer, unfettered, except in so far as the above recommendations are concerned, should be instructed to prepare a scheme for supplying electricity for power and lighting, with a view to the same being submitted to the Council, and subsequently to the Local Government Board for approval, and for the sanction of the last named body to the necessary loan for carrying out the scheme if the Council should approve thereof" Mr. Willoughby, in moving the adoption of the recommendations, referred to Dr. Fleming's report, and added that, excluding places where cheap and nasty experiments had been made, he (Mr. Willoughby) had not succeeded in finding a failure on the part of any corporation that had adopted the electric light. Taken in conjunction with the service of tramways, it was most desirable that they should have the electric light. If from April to November last they had electric power for their cars, such as they saw in Bristol, they might have saved in 12 months—taking the average for the period named—nearly £4,000. Horse power cost them 10½d. per car per mile, whereas in Bristol the electric power cost 5d. If they could save so much under present conditions, they would save more if the lines were coupled up. A station both for lighting and power must reduce the cost of both. After some discussion an amendment, omitting the tramways portion of the scheme, was rejected by 25 votes to 12, and the report of the committee was adopted.

Messrs. E. Scott and Mountain.—This firm report from Newcastle that during the past year a large increase in the turn-out of plant for electrical transmission of power has taken place, and some important contracts for electrical pumping, hauling, winding, etc, have been completed. A large transmission of power plant has been shipped to South America. comprising two generating dynamos, two sets of winding gears with all requisite switches and other appliances, two electrically-driven fans for the workings, a set of electrically-driven air-compressors, and also pumping apparatus. This plant represents the transmission of about 160 h.p., and is considered to be one of the most complete plants yet supplied. In the Yorkshire and Lancashire districts a number of important installations have been fitted up for hauling, pumping, and coal cutting. For the Northumberland and Durham districts similar plants have also been supplied of equal and smaller powers, and for the Colonies a considerable amount of work has been done in the same direction. The generating dynamos constructed during the year for the transmission of power alone represents in the aggregate 1,000 h.p. to 1,200 h.p. Electrical coal-cutting has developed during the year, as many as six separate plants having been supplied to various collieries for this purpose. In their electric lighting department the firm have been very fully employed, many important installations having been fitted up both in the United Kingdom and abroad. The dynamos and motors comprise a large variety of sizes, varying from ¼ h.p. to 150 h.p. In addition to their standard type of dynamos and moters, the firm have introduced a special design of electrically-driven fan for ventilating on board battleships and merchant vessels. For the British navy these have been supplied and fitted on board H.M.S. "Juno," "Doris," "Venus," and "Diana. In ship-lighting the firm have also been busily engaged, and, in addition to a large number of installations which they themselves have carried out, they have supplied a large number of combined engines and dynamos to other contractors. In their engineering department they have not been any less busily employed, over 30 of their special high-speed engines having been supplied, representing a total of about 1,500 h p, these varying in size from 10 h.p. to 200 h.p. These engines are specially designed and built for driving electrical plants, and are made with single or double cylinders or of the compound type. The prospect of business in the near future is also good, as the firm at the present time are busily engaged, and have a very large number of orders still in hand in all departments. In their foundry department they have made considerable strides, and have been more fully occupied than in any previous years.

Newcastle-on-Tyne.—Before finally deciding on the adoption of the cable system for the Newcastle tramways, the Town Council decided, after a very long discussion, to send a large deputation, consisting of one-third of the members, to Bristol to make an inspection of the electrical tramways there. The deputation arrived at Bristol last Saturday, and were met at their hotel by Mr. George White, the managing director of the Bristol company, who furnished the members with a variety of details as to the working of the electric tramway, and many of the deputation availed themselves of the opportunity of an unofficial inspection the same night. On Monday morning the deputation were met by the Mayor of Bristol, on behalf of the Corporation, and Mr. George White, the managing director, and Mr. Samuel White, the secretary of the Bristol Tramways and Carriage Company, at the Royal Hotel, where a four-in-hand horse car was waiting, and conveyed them to Old Market-street. There a special electric car was in readiness, and the party proceeded over the whole of the line, and made a very complete inspection of the power station at St. George, where the tramway company's officials explained the details of the electrical equipment. After the return journey, the Mayor of Bristol, the Mayor and Sheriff of Newcastle, and the other members of the deputation were entertained by the directors of the company to luncheon at the Grand Hotel, Mr. William Butler, chairman of the company, presiding. In acknowledging the toast of "The Mayor and Corporation of Newcastle," the Mayor of Newcastle explained that their Corporation were now anxiously considering the merits of the systems of cable and electrical tramways, and he was bound to say that he and the other members of the deputation had been very much impressed with what they had seen in Bristol that day. Mr. Alderman Winter, in proposing "The Bristol Tramways and Carriage Company," said that having travelled over a large portion of the world, and therefore having seen a very large number of tramway undertakings, he was bound to express his admiration of the manner in which the Bristol tramways were managed. Mr. Low, a director of the tramways company, said the line they had inspected was authorised in the year 1891 for cable traction, and the company had gone to considerable expense in having plans and estimates prepared based on that system; but, after mature consideration, the directors unanimously felt that it would be unwise to enter upon such a form of construction, and a year or two since, after a complete examination of various electric tramways in important towns on the Continent, and by the aid of the best advice they could procure, they determined to adopt the electric trolley system. It was true that it had been working only three months, but they were perfectly satisfied that this system was the best which could possibly be adopted in the city, not only for the company, but for the travelling public, and they had already informed the Corporation of Bristol that they were ready to engage in the very large outlay which would be necessary (practically the doubling of their present capital) to extend the benefits of electricity to the remainder of their tramway system, and, in addition, the company were ready to extend the advantages of an electric tramway service to other districts which hitherto had been inaccessible to horse power. They hoped and believed that, as a result of the negotiations which they were about to enter upon with the Corporation, a very large extension of electric traction would take place in Bristol. The report of the Council was presented at a special meeting of the City Council on Wednesday. It recommended that application be made to Parliament for additional provisions to be inserted in the present Bill which would include the Westgate-road, Arthur's-hill, Elswick-road, Scotswood-road and Byker tramways within the power to work by electricity; and that in the meantime the whole question of dealing with the tramways of the city be referred back to the Town Improvement Committee. Sir Charles Hamond, M.P. moved an amendment to the report that the Bill be withdrawn from the present session of Parliament, and that the whole matter be referred back to the committee in order that they might decide which system was the better system for the Newcastle tramways This amendment was lost by 31 votes to 16, and the report was adopted by a majority of 1. A meeting of ratepayers was afterwards held. The Mayor proposed a resolution authorising the Council to promote the Bill. This was seconded by Mr. B. J. Sutherland, and after a heated discussion was declared lost on the show of hands. A poll was demanded, it is understood, by Mr. Frank Marshall, solicitor to the tramways company.

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PROVISIONAL PATENTS, 1896.

JANUARY 1.

64. Improvements in or relating to electric tramways or railways. Francis Krizik, 433, Strand, London. (Complete specification.)

JANUARY 2.

94. An improved regulating and feeding mechanism for electric arc lamps. Harold Sisson Jacques, Municipal Offices, Cheltenham.

130. Improvements in and relating to electric accumulators. Robert Jacob Gülcher, 6, Lord-street, Liverpool. (Complete specification)

135. A new or improved method for the adjustment of carbons in electric arc lamps. Vincent Fabris, 64, Mark-lane, London.

JANUARY 3.

156. Improvements in regulating the supply of gas or electric light to railway coach compartments. Herbert Tatham Procter and Robert Edwin Gill, 154, St. Vincent-street, Glasgow. (Complete specification)

207. Improvements in electric arc lamps. William Phillips Thompson, 6, Lord-street, Liverpool. (The Electric Arc Light Company, United States.) (Complete specification.)

234. Cycles electrically driven by means of electricity collected from fixed conductors for track-pacing and other purposes. Robert Alfred Marples, Tyndale Lodge, Highland-road, Bromley, Kent.

JANUARY 4.

265. An improved reflector for electric glow lamps. Henry Nield Bickerton, 64, Barton-arcade, Manchester. (Complete specification)

270. Improvements in incandescent electric lighting apparatus. Sidney Harper Heywood, 5, John Dalton-street, Manchester.

306. Improvements in the manufacture of electrical hot-plates and other electrical apparatus for cooking and heating purposes. John Chambers, 7, Staple-inn, London. (Date applied for under Patents etc., Act, 1883, Section 103, November 8, 1895 being date of application in New Zealand)

308. Improvements in electric switches. Charles Solomon Newman, 226, High Holborn, London.

JANUARY 6.

342. A new or improved combined portable electric light and current generating apparatus. Joseph Rabitean Welland, 22, Glasshouse-street, Regent-street, London.

347. An improved switch for electrical purposes. Charles Bruce Wood, 97, Newgate street, London.

355. An electrical regulator for regulating arc lamps and for other purposes. Albert Lewis Davis, 28, Southampton-buildings, Chancery-lane, London.

JANUARY 7.

390. Improvements in electrical switches. John Theodore Leroux, 24, Temple-row, Birmingham.

434. New and useful phase-completing device. Theodore McKenna, 17, Basinghall-street, London. (Electric Selector and Signal Company, United States. (Complete specification.)

452. Improvements in apparatus for controlling electric motors. Henry Harris Lake, 45, Southampton buildings, Chancery-lane, London. (Bradley Allan Fiske, United States.) (Complete specification.)

474. An improved turning-plate for electrically or mechanically propelled vehicles. Walter Charles Bersey, 53, Chancery-lane, London.

475. Improvements in electric accumulators. Walter Charles Bersey, 53, Chancery-lane, London.

477. Improvements in electrical storage accumulators. Charles Nigel Stewart, 53, Chancery-lane, London.

JANUARY 8.

533. Improved automatic remontoir apparatus for Hughes's telegraph apparatus. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

535. Improvements in primary and secondary batteries. Henry William Headland, 77, Chancery-lane, London.

543. Improvements in or relating to means for producing differences of phase in alternating-current apparatus, specially applicable to meters, motors, and the like. Georg Hummel, 46, Lincoln's-inn-fields, London.

546. Improvements relating to electric incandescence lamps, and to adapter fittings therefor. Reuben James Bott, 11, Southampton-buildings, Chancery-lane, London.

547. Improvements in devices for joining or connecting electrical cables or conductors. Henry Edmunds, 47, Lincoln's-inn-field, London.

551. Improvements in dynamo-electric machines and motors. Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

557. Improvements in electric batteries. Richard Collins and Frederick Cogan, 45, Southampton-buildings, Chancery-lane, London.

565. Improvements in apparatus for transforming continuous electric currents. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Cie. de l'Industrie Electrique, Switzerland.)

SPECIFICATIONS PUBLISHED.

1891.

185. Dynamo machines. Crompton. (Second edition.)

1892.

2330. Electric switches. Gimingham. (Second edition.)

1894

24285. Electric lighting of trains, etc. New and Mayne

24541. Effecting electrolysis. Kellner.

25066. Dynamos and motors. Atkinson.

1895.

297. Electrolytic treatment of tin, etc. Claus and Sutton.

378. Electric generators. Fletcher.

831. Arc lamps. Quin and Symmons.

1317. Electric lamps. Hacking and Brand.

1405. Arc lamps. Barrière.

1731. Secondary batteries. Faure and King.

2004. Electric recording meters Mills (Wirt.)

3006. Arc lamps. Burnand.

3580. Sulphonic acids. Newton. (Bayer and Co)

3582. Electric conductors. Reason.

3633. Distributing electricity. Parker and others.

3701. Vehicle electric driving gear. Bersey

4672. Telephone and telegraph systems Lake. (Shea and another.)

8967. Insulating material for cables. Gentzsch and others.

9864. Suspending arc lamps, etc Quinn and Philpott.

13436. Electric light fittings Miller.

18038. Electrodes. Leitner and Reicher.

19947. Electric contact devices. Moradelli.

20435. Electric brakes. Devonshire. (Case)

20883. Telephonic, etc., systems. Justice. (Nixon.)

21556. Telephone transmitters. Thompson. (Hammacher and Paetzold.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1-1½
—— Non. Cum., 6 per cent. Pref.	2	1¾-2
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5¼-5¾
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7½
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	12½-13½
—— 6 per cent. Cumulative Pref.	10	15½-16
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	128-130
—— 5 per cent. Pref. Shares	10	14¾-15½
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10½-11
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¼-1¾
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅜-½
—— 7 per cent. Cumulative Pref.	2	2-2½
Elmore's Copper Depositing	2	¼-½
Elmore's Wire Company	2	⅜-½
Fowler-Waring Cables	5	¾-1
W. T. Henley's Telegraph Works, Ordinary	10	13½-14½
—— 7 per cent. Preference	10	15½-16½
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4¼-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	19-20
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7¾-8¼
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7¾-8¼
Liverpool Overhead Railway	10	11⅛-11⅝
—— 5 per cent. Pref.	10	15¼-15¾
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅜-½
Metropolitan Electric Supply	10	10¼-10¾
—— 4½ per cent. First Mortgage Debenture Stock	100	114-117
National Telephone, Ordinary	5	5¼-6
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15½-16½
—— 5 per cent. Non. Cum. Third Pref.	5	6¼-6½
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	8½-9
Oriental, Limited, £1 shares	1	1¼-1⅜
—— £5 Shares	5	7¾-8¼
—— £4½ shares	4½	6¼-6¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-106
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8¼-8¾
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	41-43
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	4¾-5
Westminster Electric Supply, Ordinary	5	8¼-9
Yorkshire House-to-House	5	6¼-7¼

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NOTES.

American Tramways.—The total length of the street railway lines in the United States equals 13,176 miles, of which 10,238 miles are run by electric power.

Trinity House.—The appointment of scientific adviser to the Trinity House, which has been in abeyance since the resignation of Dr. Tyndall, and which was formerly held by Prof. Faraday, has now been revived and conferred upon Lord Rayleigh.

Fatal Accident.—On Wednesday evening, Edward Clarkson, in the service of Messrs. Siemens Bros., electrical engineers, whilst at work at the lighting station at Hampstead, accidentally received the full force of the current, and was killed instantly.

Birkenhead.—We understand that the municipal authority, under the advice of their consulting engineer (Mr. J. Shoolbred), have adopted the higher pressure now permitted by the Board of Trade, and will be known to history as having been the first municipality to do so.

Obituary.—We regret to announce the death of Sir Henry George Calcraft, which occurred on Thursday afternoon at his residence in Mount-street, Grosvenor-square after a brief illness, from pneumonia. He was a director of the National Telephone Company, and till 1893 permanent secretary to the Board of Trade.

The South African Cables.—Last Monday the predicted breakdown of the two lines really occurred, the postal telegraph authorities announcing that the cables between Lourenço Marques (Delagoa Bay) and Durban on the East Coast and St. Thomas and Loanda (Angola) on the West Coast were interrupted, thus completely cutting off communication with South Africa.

Illuminated Life Buoy.—According to *Die Vedette*, a German naval captain has invented a new life buoy. It consists of a large cork ring capable of floating three persons. Its principal feature, however, is that it is fitted with an electric light, fed by a small accumulator which will store sufficient electricity to keep the lamp alight for 24 hours. That seems a most uncomfortably long period to remain in a life buoy.

Collectors' Lamps.—The ticket-collecting staff at the Vauxhall Station of the London and South-Western Railway have been fitted with the electric light. That is to say, they carry small electric lamps, which are fixed on their overcoats, the current being supplied from a miniature battery carried in the breast pocket. The experiment is to be tried for a month, and if it finds favour with the officials electricity will supersede the old-fashioned and somewhat cumbersome hand-lamp.

The "Swan" Fountain Pen.—Messrs. Mabie, Todd, and Bard, of Cheapside, have sent us one of their "Swan" fountain pens. To literary and to business men a really good and reliable fountain pen is of great value, and after a fair trial we have come to the conclusion that the "Swan" pen is one of the best of its kind. The nib is of gold, the ink flows freely, and the pen can be very easily cleaned when required. The price of the pen, including glass filler, is 10s. 6d.

King of the Belgians.—King Leopold, accompanied by the Belgian Ambassador, visited the works of the Waterloo and City Railway last week. After being clad in appropriate costume, his Majesty descended the shaft in the River Thames and was conveyed along the contractor's electric railway to the working faces at the City end of the railway, which have now reached a point in Queen Victoria-street, near St. Nicholas's Church. The party then returned towards Waterloo and inspected the working of the air-lock, the tunnels at this end of the line being driven under compressed air. His Majesty spent nearly an hour on the works.

Institution of Junior Engineers.—The eleventh anniversary dinner of the Institution of Junior Engineers will take place next Saturday at the Westminster Palace Hotel. The president, Mr. Archibald Denny, will take the chair, and will be supported by Mr. James Dunn, acting director of naval construction, Mr. A. J. Durston, C.B., engineer-in-chief of the navy, Sir Donald Currie, K.C.M.G., M.P., Mr. John M. Denny, M.P., Mr. E. Windsor Richards, Dr. John Perry, and Profs. J. Harvard Biles and Carlton J. Lambert.

Brooklyn Tramways.—According to the *Brooklyn Citizen*, Chief Inspector Franklin, of that city, has reported that the running time on some of the trolley roads has been reduced. As a result, the speed of the cars has been increased, and it is stated that in one case a car was seen going along Nostrand-avenue at over 24 miles an hour. Accidents have naturally resulted. Our contemporary urges that rapid transit is impossible on a street line of any description. It may not be impossible, but it is certainly undesirable.

Telephone to Berlin.—The *Financial Times* considers that the London and Paris telephone has been an immense success, but it has long been felt that it would be advantageous to have other Continental centres brought into vocal communication brought with our little village. In the German Reichstag Dr. Stephan, the Postmaster-General, has stated that it was intended to establish direct telephonic communication between London and Berlin. "The new departure," says our contemporary, "will be a boon to business men, and it will also be convenient for the German emperor whenever that potentate feels disposed to send lively messages to this country."

Accumulator Cars.—The Berlin-Charlottenburg Tramways are trying to solve the problem of electric traction on the accumulator system. A new type of car built for and now working on a section of this line carries 20 passengers in the interior and nine passengers on the platform, or with the motorman and conductor altogether 31 persons. The power is derived from a 124-cell Schäfer and Heinemann accumulator, arranged under the seats. This supplies current to a two-pole 18-h.p. motor, the potential being 250 volts and the current 60 amperes at 300 revolutions a minute. The intermediate gearing runs in oil. There appears to be no new principle involved in the construction, and the efficiency claimed can only be determined after a more extended trial.

Trans-Pacific Cable.—An Inter-Colonial Conference of Postmasters-General has been held in Sydney, N.S.W., concerning the appointment of Australian representatives on the Pacific Cable Commission to be held in London. Resolutions were adopted, subject to the approval of the Colonial Governments: "That a cable should be constructed and owned jointly by the various Governments interested. That the landing of such cable should be only upon territory belonging to or under the control of the British Empire. That the cost of construction, working, and maintenance be borne by Great Britain, Dominion of Canada, and the contributing Australasian colonies in proportion of one-third. That the route from Fiji to Australia be to Norfolk Island, and thence bifurcating to the nearest convenient landing places in North New Zealand and Moreton Bay respectively."

Dundee Mechanical Engineers.—Last week Mr. Henry Cameron lectured on "Friction" to the Dundee and North of Scotland Institute of Mechanical Engineers. Mr.

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D. J. Macdonald presided. The lecturer stated that some time ago he made practical experiments with different kinds of metals, chiefly of the soft or white metal type, but of different compositions. The chief lessons he learned from the experiments were that there was not such a very great difference in the actual usefulness of soft metals of different compositions, and that those composed of the cheapest materials stood the test fully as well as those composed of the dearest; that those with a basis of lead stood as well as those with a basis of tin. The proportions were very elastic, as shown by the fact that in the German navy there was used a composition which was nearly all tin, and in the French navy a composition which was nearly all zinc.

North-East Coast Engineers.—At the fourth meeting of the present session of the North-East Coast Institution of Engineers and Shipbuilders, held in the hall of the Literary and Philosophical Institution, Newcastle, Mr. J. R. Fothergill, in the absence of the president, occupied the chair. A hearty vote of thanks was given to Mr. W. Cross for his paper on "Plant at the Newcastle and District Company's Electric Light Works, Forth Banks, Newcastle." Mr. J. Denholm Young's reply to the discussion on his paper "On the Application of the Law of Similarity of Marine Propellers" was read to the meeting by the secretary (Mr. John Duckitt), and a paper on "Counter-Sinking in the Shipyard" was contributed by Mr. Robt. H. Muir. An interesting discussion took place on Mr. J. M. Allan's paper on "An Investigation into the Forces Tending to Produce Vibration in High-Speed Engines." Part I. of the *Transactions* of the institution has been printed and issued to the members.

Goods Train Brakes.—The *Times* considers that it would be a desirable thing if continuous brakes were fitted to the goods trains on English railways. Neither the automatic vacuum nor the Westinghouse automatic brakes used in this country are suitable to very long trains, the distribution of pressure not taking place quickly enough. The brakes, therefore, may be hard on in the front of the train while unaffected in the back part, and the attempt to effect a rapid stop of a long train will certainly result in violent jerks. However, forms of brake have been designed which can quite well be used on the longest trains. The Westinghouse quick-acting brake, for instance, a modification of the ordinary Westinghouse, is extensively used on goods trains in the United States, while even quicker results might be obtained from an electrically-controlled apparatus, such as Carpenter's electro-pneumatic brake. As to the Chapsal electric brake, which some time ago was noticed in these columns as specially designed to meet the needs of goods trains, no further details as to its construction have up to the present appeared.

An American Invention.—Mr. E. B. Dunn, chief of the Weather Bureau in New York, has invented a system of alarm signals for the purpose of preventing rear-end collisions on railways. Wires are run along the telegraph poles and connected to the train despatcher's office. The poles carry a switch and a red lamp, and when a train is stopped the trainman is expected to go to the nearest telegraph post, probably in the dark, and by turning a switch light up all the lamps on the poles behind the train, as well as one in the despatcher's office. This would be a highly effective way of notifying to the public as well as the following train that an accident had occurred, if the trainman did not happen to be hurt in the accident and the apparatus had not got out of order, as emergency apparatus which are seldom used have a way of doing. In Great Britain, in a similar case, the guard simply takes the red lamps off the tail of the train and walks down the line with them as far as he thinks necessary, which ought to come to much the same thing. The mystery is why the Americans cannot adopt a block system and save all this invention. It might not be so pretty, but it would be certainly more effective than Mr. Dunn's electric signals.

Utilising the Scorcher.—In reference to an abstract of an article in *L'Etincelle Electrique* given by us under the above title we have received a letter from the Crypto Works Company, Limited, 29, Clerkenwell-road, pointing out that at the National Cycle Show held at the Crystal Palace towards the end of 1894 a front-driving safety bicycle arranged for driving a small dynamo was exhibited by them. The dynamo was used to supply current to some small fan motors, incandescent lamps, etc., but the idea really was that the arrangement could be used during winter months as a kind of home trainer, the dynamo acting as a brake to the wheel, and accumulators being charged by the current, to be afterwards used for night-light, reading-lamp, etc. The Crypto Company add: "We made a number of experiments, and found that a good rider could maintain an output of 50 watts practically for any length of time. The output mentioned in your note—viz., 140 watts—seems high; we do not think it could be kept up for sufficient time to be of real service." In this respect our correspondents are undoubtedly right; even if there were no waste of power, the output expected was obviously excessive. The article was noticed by us as being curious, but the idea was, of course, not a new one.

The Berrenberg-Chaplin Vacuum Pump.—A report by Prof. W. E. Ayrton, F.R.S., on the practical value of this pump, which we described in our issue of the 10th inst., has reached us. After a long and careful series of trials, Prof. Ayrton reports that the pump produced in 21 minutes a better vacuum than that found in any of the eight typical commercial lamps he tested. The time required for obtaining different degrees of vacuum was as follows: in $2\frac{2}{3}$ minutes the pressure in the bulbs was $\frac{1}{100000}$th of that of the atmosphere; in 15 minutes it had fallen to $\frac{1}{2500000}$th, and in 21 minutes to $\frac{1}{3333000}$th, as measured on a McLeod gauge. After testing the pump against a small leak in the system, and after admitting air to the cylinders, Prof. Ayrton concludes that the combination of pumps as erected at 4, Huggin-lane is capable, in 15 minutes, of creating a vacuum as good as that in the best, and much better than that in the worst, of the incandescent lamps he examined, and that it is capable, in 20 minutes, of creating a vacuum much better than that in any of the lamps broken under mercury; that the system of pipes, cocks, and glass stoppers is for all practical purposes perfectly air-tight; and that even should a small leak occur the pumps are able to work against it until it is remedied.

Bad Electric Lamps.—Correspondence and complaint on this subject still continues in the daily Press. What the *Daily News* had to say on the subject was dealt with last week. The *Daily Telegraph* now takes up the tale, the burden of the advice given being, "Don't buy cheap German electric lamps." Lamps which are short-lived are generally found to be those that are imported. One large firm, which acknowledges that even patriotism would not prevent its orders being placed in the cheapest market, declares that it has been impossible of late to accept even the best German incandescent lamps. The samples when tested prove themselves to be all that can be desired, but the goods, when once they come to hand, are not up to sample. Lamps which pretend to be of 23 c.p. have been revealed under the test as of 14 c.p. only, and it is inferred that this wide margin could not have been due to accident. Under the title of "The Life of a Charcoal Thread," the *Daily Chronicle*,

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in endeavouring to make its readers understand the theory of the matter, becomes quite poetical. "There is, indeed," says our contemporary, "something about its glowing charcoal thread that touches us on the human side. We see it start its normal life of a thousand hours with the bright fervour of youth, then pass into the steady glow of maturity, finally enter on its decadence, old age, and ultimate death. Like the human organism, it may live its life too fast. If an excessive energy be passed through its mortal coil, the whole span of life will pass in a few minutes, even seconds."

University of London.—At the Society of Arts last week, Prof. S. P. Thompson read a paper on "The Making of a Great University for London." Lord Reay presided. Prof. Thompson said that the only really comprehensive scheme of reconstruction of the University of London was that of the second Royal Commission under Lord Cowper, which unanimously reported against the Gresham scheme. In condemning the constitution of the present university, he pointed out in the course of his lecture that in the regulations for the degree of Bachelor of Science not a line had been changed since 1876 in the syllabus of subjects for the examinations in such progressive sciences as chemistry and physics. No questions could be asked in chemistry about argon or helium, or even about so fundamental a topic as the periodic law. No questions could be asked in physics about the microphone or the phonograph, about alternating currents, or about Hertz's classical researches on electric waves. What they did not find in the text-books of 20 years ago was not science. At a university convocation on Wednesday a resolution proposed by Prof. Thompson, "That this house desires the early introduction into Parliament of a Bill for the reconstitution of the university similar to that introduced last year by Lord Playfair, but with an inserted clause ecuring to the senate, to convocation, and to other bodies affected the right of appeal to the Privy Council on any of the provisions which may hereafter be settled by the Statutory Commission," was carried by 466 votes to 240.

The Telephone in Colombo.—England is not the only country which suffers from unsatisfactory telephonic arrangements. According to the *Ceylon Times*, Messrs. Murray, Robertson, and Co., as agents of the local telephone company, have intimated to subscribers to the exchange that the telephone business hitherto conducted by them will be discontinued from December 31 last. The announcement is a rather sudden one, but the decision is the outcome of the threatened competition of Government through the Post Office. For two years negotiations have been going on between Government and the local telephone company, and the Telegraph Department would have before now taken over control of the telephone by buying up the existing service had the Government been willing to accede to the company's terms. Much correspondence was carried on, which was referred to the Secretary of State, and the company being apparently tired of it has decided to give up the field, and as nearly all subscriptions lapse at the end of the month, it was deemed desirable to close them. The matter has advanced but little at the Post Office, however, and there is a likelihood that Colombo will be without a telephone service for several months. The local Government has referred the matter to the Secretary of State to know whether better terms shall be offered for the existing service or whether new plant shall be got out from England. The company claim to have been badly treated, and they will now sell their business to the highest bidder.

Hertzian Waves.—In a review of the progress of electrical science during the past year, *L'Industrie Electrique* remarks that the work of Hertz lives after him and the subject of electric waves keeps still to the front. During the year their domain has been extended from the simpler cases to the elucidation of complex phenomena, and the parallellism between the electromagnetic undulations and light waves has been perfectly established. M. Lebedev has produced Hertzian waves of much smaller dimensions than heretofore obtained. Other investigators working on a larger scale have found clear traces of their double refraction in wood, the velocity of propagation being different across or along the grain. A similar effect has been obtained from dielectric media artificially arranged so as to have different properties along different axes, and the phenomena are clearly brought out in a cube composed of layers of paper. The phenomena corresponding to diffraction have hitherto been little considered, except that MM. Sarasin and de la Rive in their researches used a mirror of unusual dimensions in order to avoid its effect. The phenomena being, however, necessarily much feebler than those of the directly propagated wave, their observation is very difficult and uncertain with detectors dependent upon the completion of a spark in an incomplete circuit. The review also notices the discovery of Herr Aschkinass worked out by Herr Haga at Berlin and the Japanese Prof. Mizuno at Tokio on the effect of the waves on a sheet of tinfoil mounted on an insulating surface, and cut alternately from above and below so as to leave a number of strips, forming a long zig-zag of continuous material. The conductivity of the foil is lowered after being subjected to the action of the waves, but is brought back to its former value by a slight shock.

Theory and Priority.—Whatever may prove the practical results of Prof. Röntgen's discovery, an explanation of the nature of the new radiations would be of great interest in connection with the electromagnetic theory of light. Assuming them to be of the character of ordinary rays, they must be either above or below the known spectrum. There is plenty of room between the 6mm. electric waves of M. Lebedev and the infra-red spectrum, and there are strong theoretical reasons for seeking their place there. On the other side of the spectrum there is unlimited room, since there is no known limit to the smallness of a light-wave. This latter hypothesis is one that finds favour with Mr. Campbell Swinton. There are difficulties to be got over before either can be accepted. The hypothesis of the discoverer is even more difficult. This week's *Zeitschrift für Elektrotechnik* devotes a long article to what it calls "Prof. Röntgen's epoch-making discovery," and there states that Prof. Röntgen has adopted, though with reserve, the view that the radiations are "the long-sought longitudinal vibrations of the ether." Every man has a right to invent his own ether, but the main object has been hitherto to get rid of longitudinal vibrations. The point could be settled by any method that would give the rate of transmission. Meanwhile Prof. Röntgen is not to be allowed the credit of the discovery without challenge. Mr. Leslie Miller, A.I.E.E., writing in the *Photographic News*, claims the honour for Mr. Crookes. A very serious claim of priority has been made for the Hungarian Prof. Lenard based on a communication made by him to Poggendorf's *Annalen für Physik. und Chemie.* in 1894 with reference to photographs obtained from the cathode rays. If he did not make the actual discovery, he most nearly missed it. The claim of Prof. Zenger, of Prague, will hardly be treated so seriously.

Crookes Tube Radiations.—Mr. A. A. Campbell Swinton has lost little time before repeating in this country Prof. Röntgen's experiments in the new photography, and exhibited some of his results last week at the Camera Club. Mr. Swinton explained that he had been guided only by the

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newspaper reports of the experiments of the Austrian professor, and that the work had been done hurriedly, and therefore he was not able to show results as complete as he could wish. What was called a Crookes radiant-matter tube was his source of influence, and he had generally used a photographic plate shut up light-tight in the ordinary wooden back of a camera. Above this he had placed various objects, and above these again the Crookes tube. The tube, under the influence of electrical excitation, gave out a certain amount of light, but this was accompanied by the newly-discovered radiations. Whatever these radiations may be, they affected the hidden plate in the same way as light, but in a far lesser degree, for the necessary exposure was from four to twenty minutes. He had not been able to learn what were the apparatus employed by Prof. Röntgen, but he himself found that no effects were evident when an ordinary induction coil was employed. He happened to have in use a lot of apparatus for high-frequency phenomena, and with this his experiments had been brought to a successful issue. He used an alternating current from the street mains which excited an induction coil; this coil charged a battery of 12 Leyden jars, the discharge of which was taken to a high-frequency coil in oil. It was the secondary coil from this latter to which his Crookes tube was joined. So far as results are concerned, Mr. Swinton found that many substances transparent to ordinary light, such as glass, are opaque to the radiations, and other opaque substances allow them to pass through freely. Ebonite, for instance, is exceedingly transparent to them; carbon, such as is used in the arc light, is the same. The metals seem to be opaque, with the exception of aluminium, but thin copper foil will also let the radiations pass. Mr. Swinton has some experiments in progress with metal plates of different thickness by which he hopes to find whether there is any analogy between their relative conducting powers for heat and electricity and their transparency for these radiations, and the results will be awaited with interest. Previous to the exhibition at the Camera Club, the writer of this note had an opportunity of seeing bromide prints of some of Mr. Swinton's plates. All the results described in the German experiments were reproduced, but in the case of the photograph of the living hand, the hand itself appeared partially transparent and showing the opaque bones embedded in it. The details of the articulations were distinct down the fingers, but were lost in the greater thickness of the back of the hand. The skeleton hand only can be obtained by varying the conditions. It is hardly likely that a sensitised plate prepared for quite a different purpose should be the best possible one also for the new radiations; and if photographs of this character could be obtained in a shorter time, they would obviously be of great use to the surgeon in cases of fracture with swelling, or in localising the position of foreign bodies. But the uses of the new discovery may be postponed for the present, although the possibility of examining the interior of normally opaque non-metallic substances is one that may easily prove of value to the electrical engineer.

Argon.—Lord Rayleigh delivered an address at the Royal Institution, Albemarle-street, last week, on the subject of "Argon." He said the first matter upon which he wished to speak was a dull but important one; it was the density of argon. At the meeting last year he had only been able to speak as to the density of argon prepared by the magnesium method. It was at that time his aim to weigh argon prepared by the oxygen method, and it was important to do so in view of the question whether argon prepared by the magnesium method was the same gas as that obtained by the oxygen process. He mentioned the difficulties he had to meet in getting three litres of argon, the amount with which he had been accustomed to work in his determinations of the densities of other gases. These difficulties were mainly due to the slow rate at which the nitrogen could be eliminated by means of the electric spark. He described the improvement he had effected in his apparatus at the suggestion of Prof. Ramsay. The nitrous fumes formed in the process were absorbed by alkali, and Prof. Ramsay's suggestion was to produce a fountain of alkali in the vessel, and so expose a larger surface for absorption of the gases. Another advantage gained was that the alkali solution welling up protected the glass from the heat of the flame. The voltage employed was about 3,000. In this arrangement nitrogen and oxygen were combined at the rate of about seven litres an hour. One curious effect was noted. Though the fountain made it quite possible to use a large arc in a small vessel, yet it was found that, everything else being equal, in these circumstances the rate of absorption was very much reduced. The determination ultimately made by Lord Rayleigh of the density of argon prepared in this apparatus was 19·940, which almost exactly equalled that found by Prof. Ramsay for the gas obtained by the magnesium process. This fact allowed the inference that the gases prepared by the two processes were identical, and also suggested, though it did not prove, that the gas was not a mixture. It was also unfavourable to the view supported by some eminent chemists that argon was an allotropic form of nitrogen, since the weight of that modification should be 21. Proceeding with his lecture, Lord Rayleigh said the next question was the refractivity of argon. He described the apparatus by which this property was examined, and the experiments he made. The result was to show that, while the refractivity of air was as 1, that of argon was somewhat less—namely, ·961. Helium obtained from a sample prepared by Prof. Ramsay was found to have a refractivity of ·146. What could be deduced from the fact? The refractivity of argon was nearly the same as that of air. He thought they could infer that it was not allotropic nitrogen, because if it were the refractivity could hardly be greater than the refractivity of air, which consisted mainly of nitrogen. The question whether any further inference could be made he must leave to chemists. Passing to his examination of the gas given off by the Bath springs, he said the proportion of argon appeared to be less than existed in the air. Subsequently, however, Prof. Ramsay discovered helium, and then it occurred to him as an explanation of this that helium, being as inert as argon, might be present in the residue, and by its lightness compensate for the heaviness of the argon. The gas from other mineral springs had been examined. Prof. Ramsay had examined that of one of the hot springs of Iceland; he found no unusual proportion of argon, and no helium at all. He (Lord Rayleigh) had examined the gas collected from the so-called nitrogen springs of Buxton. The proportion of argon in it was 2 per cent., and the indication of helium was doubtful. A good deal of interest lay in the question whether there was helium in the atmosphere. If there was any considerable portion it would be accumulated with argon, and one would expect to see the characteristic helium line in the spectrum of argon. He did not think that anyone had ever seen it. That might be taken as proof that there was not 2 per cent. of helium in argon, and as argon was only 1 per cent. of the atmosphere, there could be only about two parts of helium in 10,000 of atmosphere. Lord Rayleigh concluded his discourse with some experiments to show that the viscosity of argon is decidedly greater than that of air (1·21 : 1), while that of helium is somewhat less than air.

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COLOGNE CENTRAL STATION.

During the autumn of last year we paid a visit to the Cologne central station, under the guidance of Mr. C. P. Feldmann, and also to the municipal waterworks adjoining the central station, where we met also Mr. E. Froitzheim. These gentlemen have specially written a paper dealing with the combined municipal works of Cologne relating to water and electricity. That part dealing with the waterworks formed the subject of a paper read before the English Waterworks Engineers at Nottingham on January 11 last, and will be found in the *Contract Journal* of January 15 and 22 last; the part relating to the central station is given herewith.—ED. *E. E.*

Cologne Electricity Works,

Being the second portion of a Paper on the Municipal Works of Cologne, by CLARENCE P. FELDMANN, Electrical Engineer to the Helios Company, of Cologne-Ehrenfeld, and ENGELBERT FROITZHEIM, Chief Engineer of the Municipal Waterworks of Cologne.

HISTORICAL REMARKS.

The Cologne electric central station has been excellently described in the very comprehensive work of Mr. Coerper,* to those points which have not yet been published in English journals, or which show details of special interest.

Electric lighting was publicly used in Cologne in 1880 during the festivities in celebration of the completion of that magnificent cathedral the foundations of which were laid six centuries before. A few years after the Paris Exhibition there were several private electric plants, some of which continued working for nearly 10 years. They were then connected to the mains of the central station. One of these plants consisted of an Otto gas-engine driving a dynamo and placed in the middle of a beer-saloon without any partition walls or protective railings, thus giving light, sound, and smell at the same time. At the close of 1889 the first of the three existing plants was erected; the total number of lamps fed by these plants is 2,150 incandescent and 190 arc lamps. In the meantime the authorities had been actively preparing plans and studying the question of a municipal electric station. Towards the end of 1887, Mr. August Hegener, then manager of the gas and water works, had adjudicated upon the tenders of Messrs. Siemens and Halske, of Berlin; S. Schuckert, of Nuremberg; and the Helios Company,

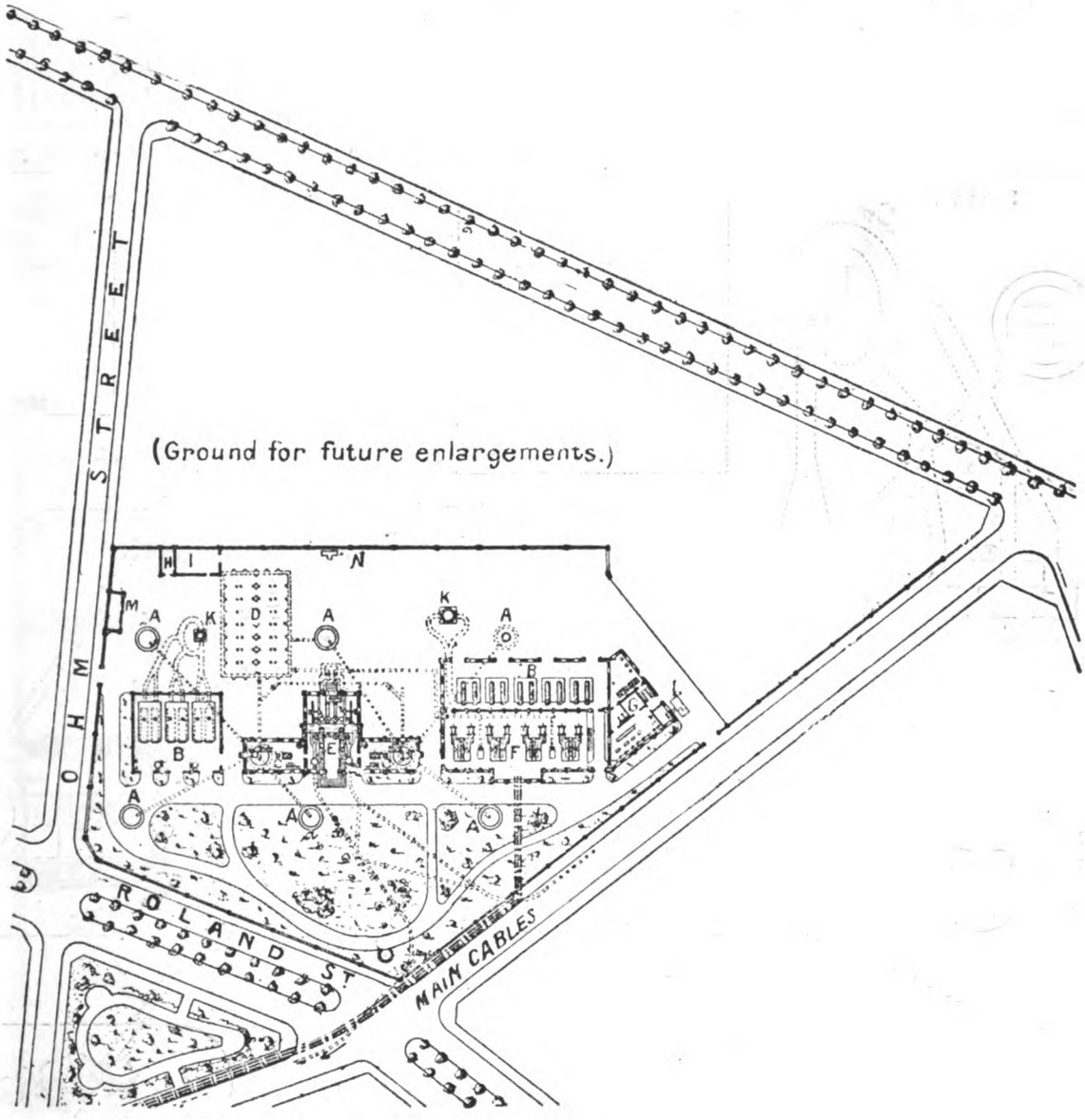

FIG. 1.—Site of Cologne Waterworks and Electric Light Station.

the managing director of the Helios Company, of Ehrenfeld, near Cologne. We shall, therefore, limit our description Limited, of Cologne-Ehrenfeld, and had stated that: "The erection of a central station, and the provision of several thousands of horse-power in engines and boilers in the centre of a closely-built town, is not at all desirable. The erection of several smaller stations with gas-motors is also not recommended on account of the high cost of the sites, the

* "The Electric Central Stations at Cologne and Amsterdam," by Carl Coerper, managing director of the Helios Electric Company, Cologne-Ehrenfeld. Translated from the German by Clarence P. Feldmann, electrical engineer.

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complicated and expensive working, and the difficulty of supervision. Therefore, a station erected near the outskirts of the town upon spare ground at the site of the waterworks would be most conveniently situated. A station so situated would be economically worked by using the alternating-current system with transformers. Again, the danger connected with this system on account of the high pressure can be reduced to a minimum by a careful installation, the inferiority of the alternating arc lamp being only a small matter as compared with the other advantages. "Therefore," his report concluded, "the alternating-current system with transformers is to be preferred for Cologne, and its employment is recommended." In accordance with this report the authorities of the city accepted the tender of the Helios Company, and granted the necessary means on February 13, 1890. The building was commenced in April, 1890; 17 months later the 600-h.p. engines and dynamos were working upon the network; buildings,

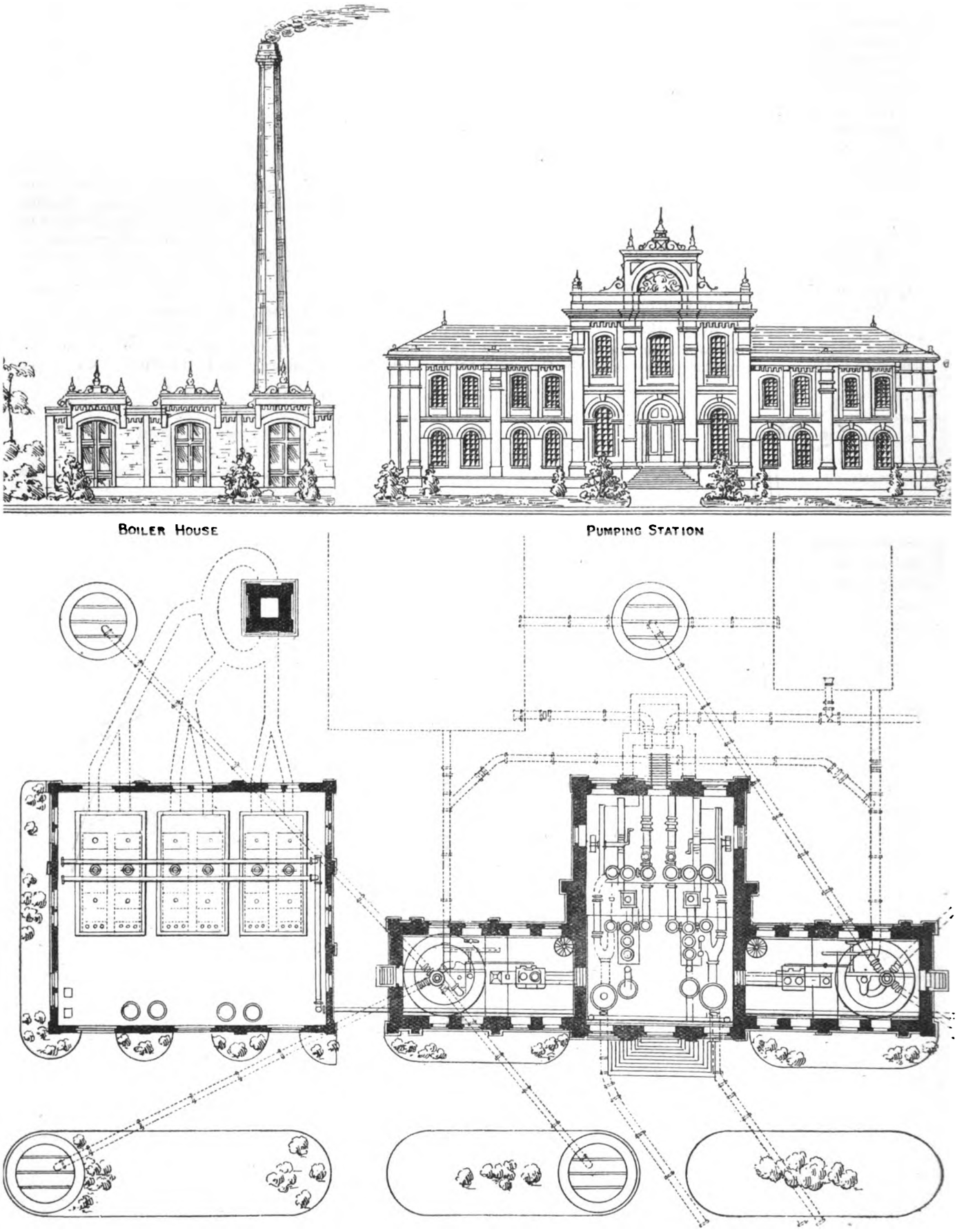

FIG. 2.—Plan and Front Elevation of the Cologne Waterworks.

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travelling cranes, engines, and dynamos were supplied by different manufacturers, their erection being carried out under the supervision of the gas and water works engineer.

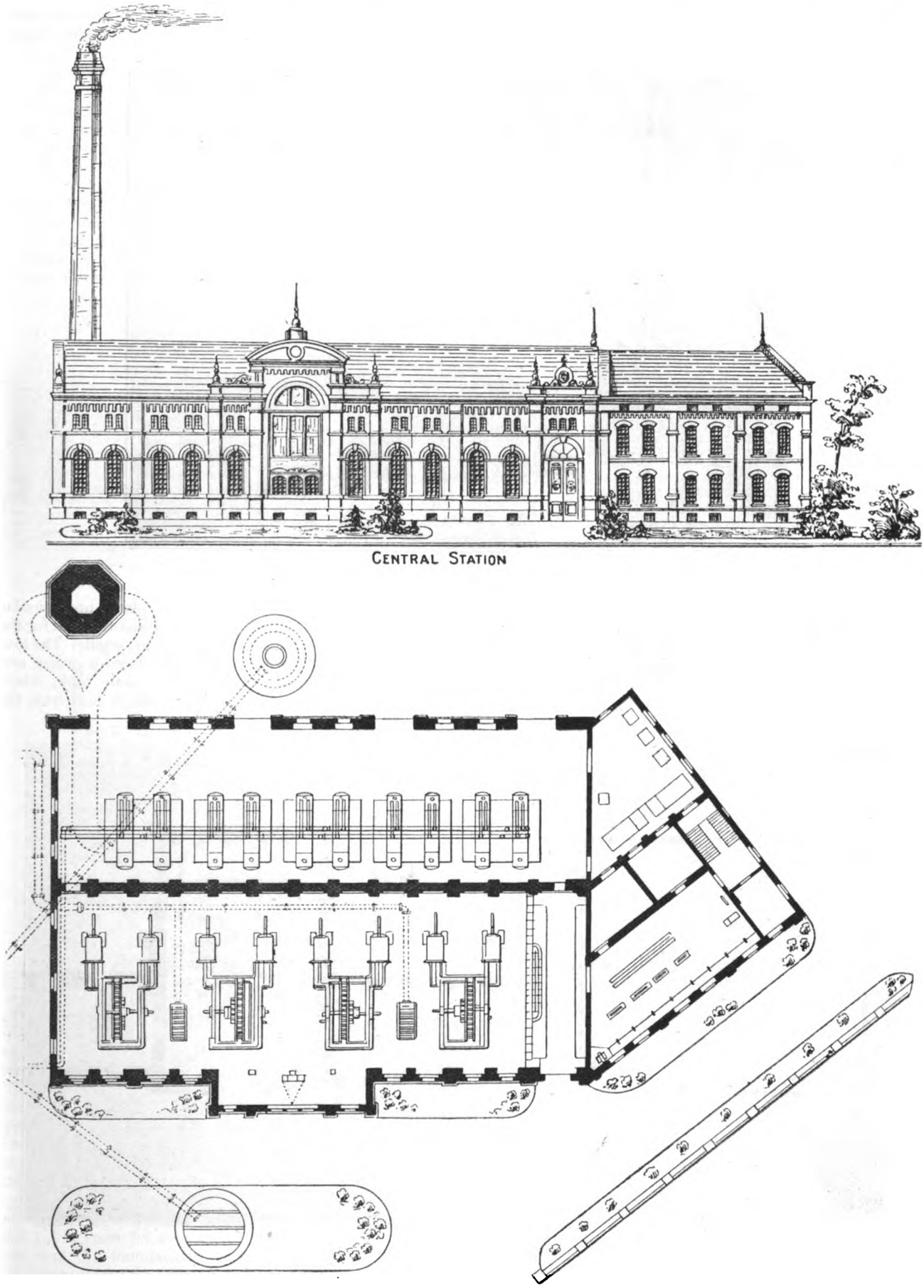

FIG. 2A.—Plan and Front Elevation of the Cologne Electricity Works.

Up to the present time there has been no failure, and the guarantees have all been reached or surpassed.

BUILDINGS.

The situation of the buildings is seen from the plan (Fig. 1) and shown on a larger scale in Fig. 2. The works consist of the engine-room, F; the boiler-room, B; and the triangular rooms, G, which contain a workshop, two laboratories, a waiting-room near the weighbridge, and a room for the feed pumps and water-purifiers. The simple but tasteful form of the front elevations is shown in Fig. 2. The length of engine and boiler room is 150ft., breadth 52ft. 6in. and 42ft. 6in. and height 52ft. 6in. and 36ft.

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respectively. Under the engine-room there are two cellars, each about 11ft. 6in. in height. The upper cellar contains the air-pumps and the exhaust-pipes from the engines, the artificial load resistances, and the connecting wires from the dynamos, and a special opening is provided in the foundation under every dynamo for the valves and condenser connections of the engines. Thus every important part is easily accessible, and may be inspected at any time. The lower cellar contains the condensing-water service pipes and tanks, and is nearly on a level with a water-reservoir between the pumps of the waterworks. The vaults below the boiler-house contain the usual arrangement of flues and ashpit, and in front of them are two long tanks for the softened water, with an overflow towards the reservoir below the softeners, from which the feed-pumps force the water into the boilers. Fig. 3 shows the interior of the engine-room.

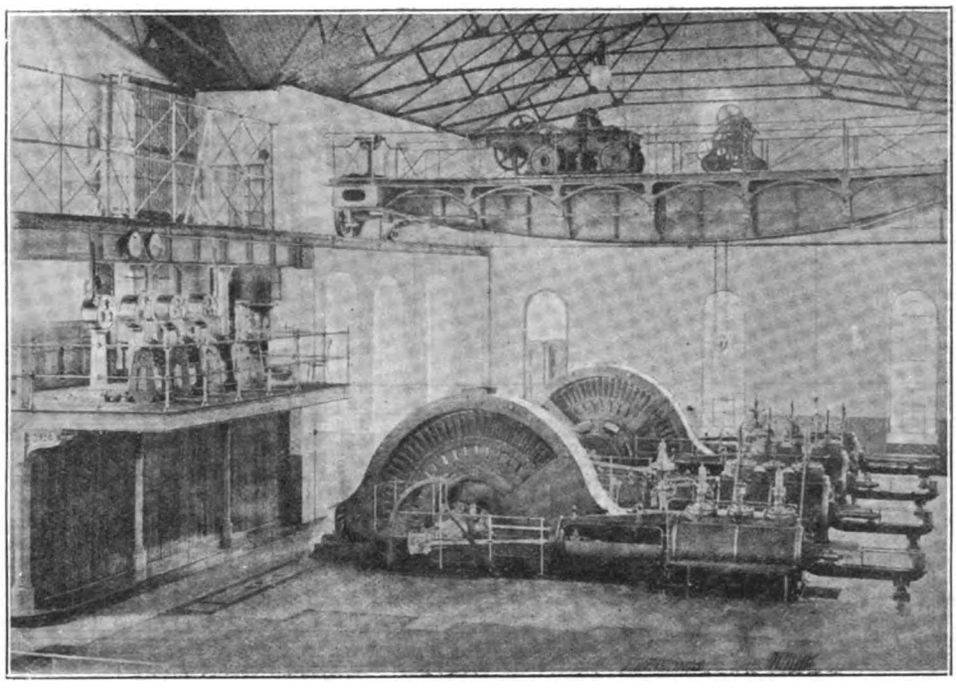

FIG. 3.—Interior of Engine-room at Cologne.

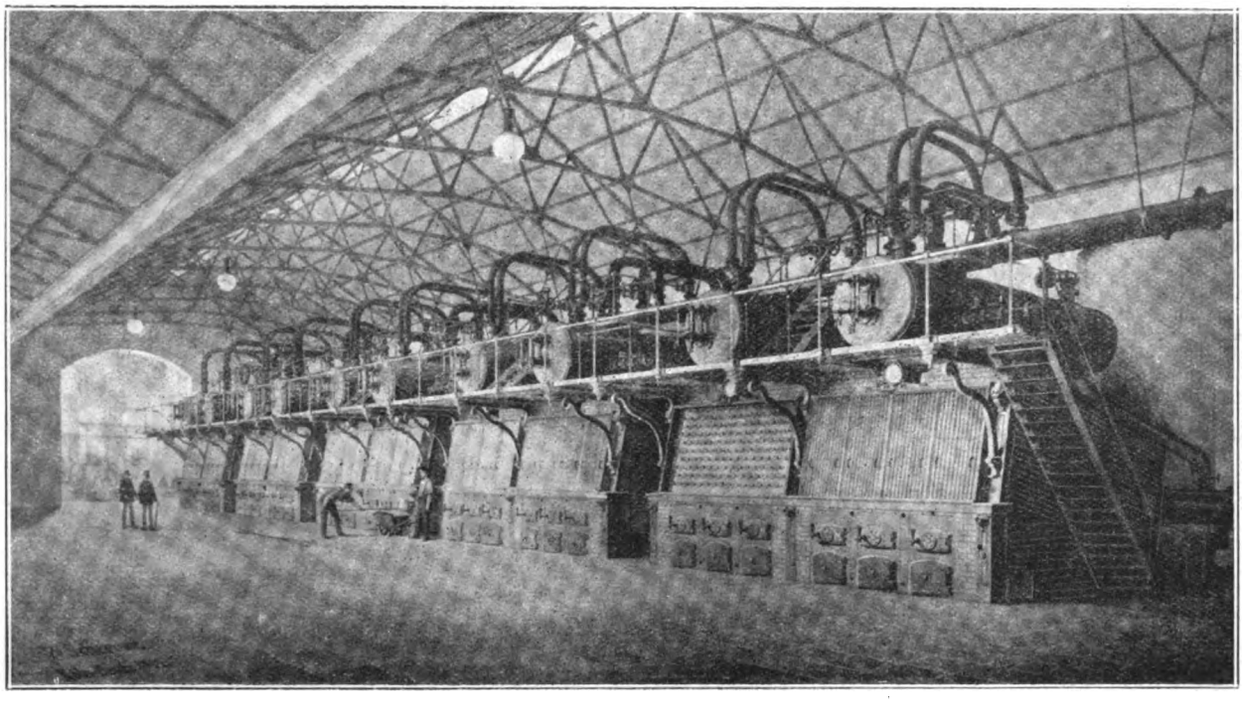

FIG. 4.—View of the Boiler-house.

ENGINES.

The engines are of the well-known Sulzer type. They are horizontal compound engines, with cylinders of 27¾in. and 37½in. diameter and 4ft. 1½in. stroke. At 85 revolutions per minute and a pressure of about 85lb., and 22 to 38 per cent. cut-off, they yield 500 to 650 effective horse-power. There are at present three engines, the fourth being a smaller one-cylinder engine giving 150 effective horse-power. It is placed upon similar foundations as the three large ones, and was designed for the day load, for which, however, it is now too small. The low-pressure sides of adjacent engines are placed together, and take their condensing water from the same tank, which is placed below the two staircases which lead from the engine-room to the first cellar. The air-pumps are worked by means of a swinging arm from the main crank. The dynamo and exciter are placed upon the main shaft without special flywheels. Only the small engine has a separate flywheel of relatively small size. The regulation of the engines is so good and the number of revolutions varies so little that synchronous clocks may be worked from the

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dynamos, this being the most delicate tachometer that could be imagined. To this point we shall return later on.

Boilers and Accessories.

The boiler-house is designed for 10 tubular boilers, of which eight of Steinmueller's system are erected. Each boiler has 2,350 square feet of heating surface, and contains 140 water-tubes, 14ft. 3in. long, of 3¾in. exterior diameter, and ·140in. thick. At both ends of each boiler these 140 tubes are firmly connected to a wrought-iron water-chamber, the connection being secured by expanding rollers. Through vertical tubes these water-chambers communicate with the upper boiler, whose length is 21ft. and diameter 4ft. 3in., and which lies completely outside of the flues. The grate surface is 54 square feet. The fire-bars are of wrought iron, their width being ·315in., spaced ·150in. apart. The grate thus formed is a very durable one, and excellently adapted for the smokeless consumption of the mixture of poor Westphalian boiler coal and the dross left after sifting the broken coke from the gasworks. The heating effect of these small particles of coke is about half of that of the coal used—1lb. of coal evaporating 8lb. of water. All feeding devices and steam and water connections are duplicated (see Fig. 4). The two steam-pipes are spirally-welded wrought-iron tubes, 12in. in diameter and ·30in. thick; they are connected by means of welded rings and loose flanges. Each of these steam-pipes may be connected to the boiler plant in the waterworks, so that the two boiler plants may mutually supplement each other. The space between the exterior wall of the boiler-house and the foundations of the boilers is arched over, and forms a reservoir for the purified feed water. It is able to hold 1,770 cubic feet of water, and thus allows of a continuous and regular working of the water-purifying devices, although the consumption of purified water varies largely with the load. Below the boilers, and near the wall separating the boiler and engine rooms, are the ashpit and the flues. The chimney stack is of circular shape, and is 8ft. 5in. diameter inside throughout, and 196ft. high. It is erected upon a concrete foundation 31ft. square, at a depth of 17ft. 6in. below the ground.

The two purifiers are each able to furnish 175 cubic feet of softened water per hour. They work continuously, and take about 13 or 14 parts of lime out of the normal amount of 16 in 100,000, leaving only between two and three parts in the feed water. The boilers have worked continuously for periods of three months. Since the opening, four years ago, there has not been the lightest trace of incrustation in the water-pipes, which are only cleansed from the small muddy deposit by means of brushes. The purifiers may be fed either from the condensing-water tank below the entrance in the engine-hall or from the waterworks supply. The softened water leaving them flows to the feed-water tanks in the boiler-room, from which it is lifted by means of compound steam-pumps, working with condensation and able to furnish 80 cubic feet per hour at 60 revolutions per minute. One pump is still sufficient for the four boilers generally in use, but three pumps have been put down.

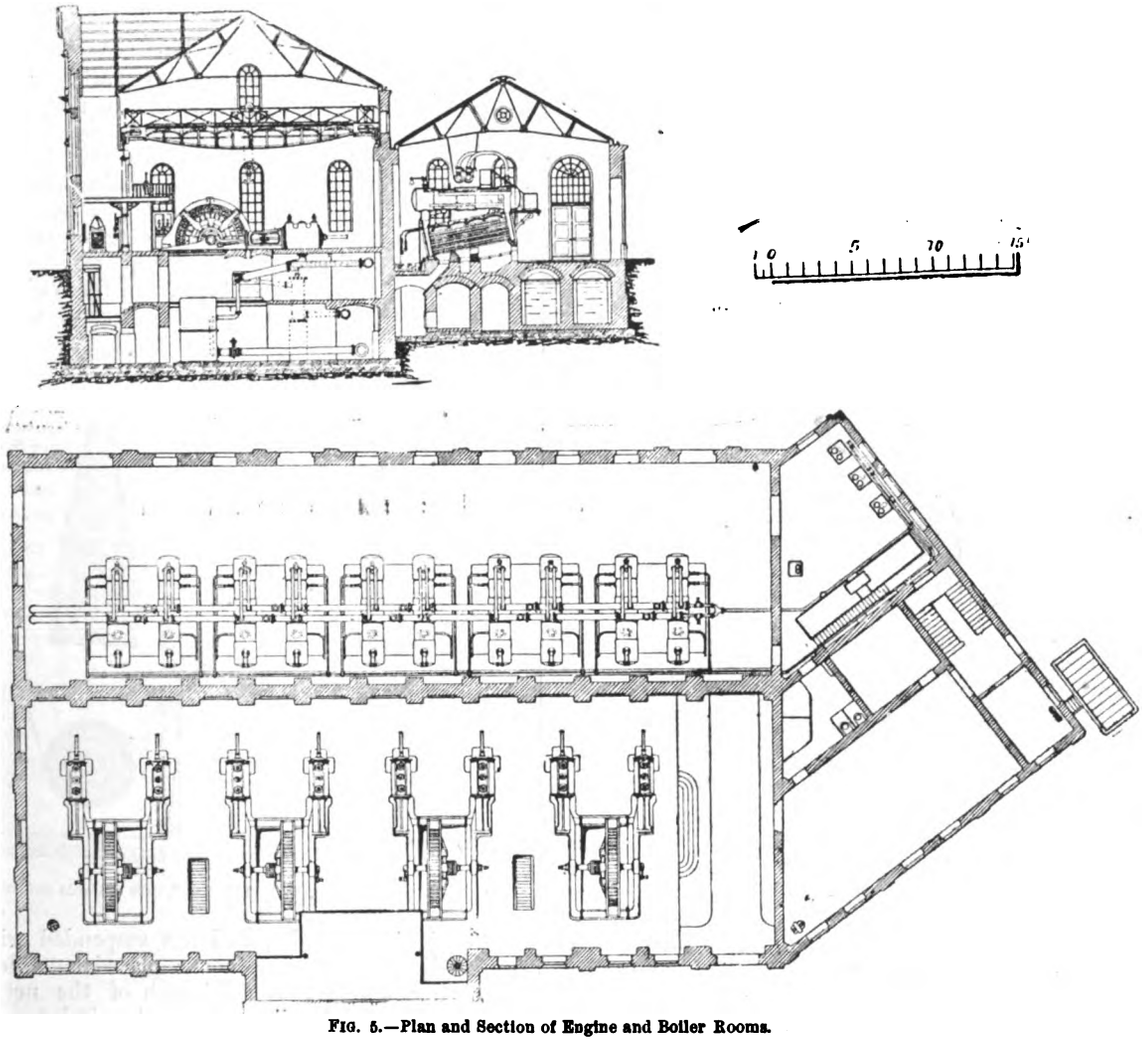

Fig. 5.—Plan and Section of Engine and Boiler Rooms.

The guarantee for the boilers was a production of 7,500lb. of steam per hour, or 8lb. per pound of coal burnt. The test, however, showed the possibility of producing with one engine and one boiler 809 i.h.p., corresponding to 11,400lb. of steam, or about 10lb. of steam per pound of coal burnt. The total amount of water in the steam-pipes and the water-separators was 162lb., with a total consumption of 29,200lb., or about 0·6 per cent. This is at once a proof of the dryness of the steam, as the total amount of water lost, of which at least a part is due to condensation, is smaller than the guarantee of 1 per cent. for water carried over with the steam. The accompanying figure shows a view of the boiler-house, with the purifiers and pumps.

Dynamos.

There are three dynamos, giving an output of 300 kilowatts normal and 360 kilowatts maximum; but they have been designed so that they may be worked at 440 kilowatts during several hours without heating more than about 25deg. centigrade above the surrounding air. Their con-

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struction is very much like that of the Zipernowski machines. The diameter of the "star" wheel forming the 72-pole field is about 14ft. 2in.; its peripheral velocity is 3,570ft. per minute at 85 revolutions. Alternators and exciters are both built up of sheet-iron stampings 19·7 mils thick, according to an English patent, No. 9,013/1887, granted to Mr. Carl Coerper. The exciters are compound wound, so as to secure a certain degree of safety. A compound-wound dynamo will always excite itself and its alternator, even if by some mistake its terminals be directly connected to the low resistance offered by the alternator field coils at the moment of starting. When coupling parallel, both alternators and exciters are connected, but each of the ring armatures of the eight-pole exciters is able to excite two alternators. The maximum output of each exciter is 130 volts and 300 amperes at 85 revolutions. In August, 1893, these dynamos and engines were tested before being finally accepted. They were loaded during 10 hours with 505·2 i.h.p., and took 14·8lb. of steam per indicated horse-power hour; the guarantee had been 15·4lb. At an output of 324 kilowatts, as measured by means of a Ganz wattmeter, the dynamo gave 544·4 watts

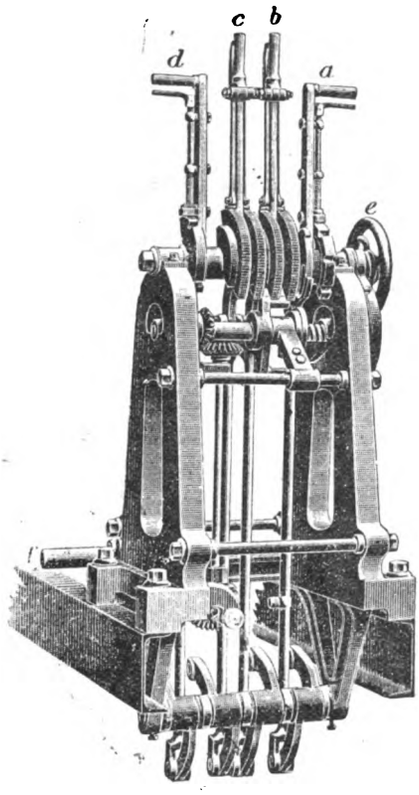

FIG. 6.—Switch Levers.

per indicated horse-power, or 640·5 watts per effective horse-power; at an output of 421 kilowatts, the respective numbers were 520·4 and 612·2 watts per indicated horse-power and effective horse-power. During these tests the E.M.F. was kept constant at 2,020 volts. The numbers mentioned include all mechanical and electrical losses in alternator and exciter. The guarantee had been 513 watts per indicated horse-power—*i.e.*, 69 per cent. efficiency.

Fig. 5 shows the dynamos and the engines in plan and section. Fig. 3 represents also the position of the travelling crane, which spans the whole width of the engine-room and is able to lift the heaviest parts. The switching platform can also be seen. The crane travels the whole length of the engine-room; it was erected before the engines, and is actuated by hand. At the end of the engine-room, before the staircase, shown in front of Fig. 5, there is an entrance wide enough to admit the largest parts of engines and dynamo. These can then be lifted by the crane and placed in their different places. In this way the engines and dynamos were erected.

Switching and Regulating Devices.

These are of special and most original design. They have been patented by Mr. Carl Coerper, and resemble somewhat the apparatus used for blocking and connecting railway tracks. Lever A (Fig. 6) controls the alternator lever; D the exciter; the levers B and C move the hands of a rheostat for fields of alternator and exciter respectively. E is a handwheel, by means of which an artificial load resistance is introduced in the main circuit of an alternator which is to be coupled in parallel or loaded for testing purposes. F is a crank connected to a set of horizontal and other levers which move the proper rheostats and switches arranged in a chamber below the platform, the double-pole switches having mercury-cups with partitions. The process of parallel coupling has been described at various places. It may suffice to state that every dynamo works 24 hours—from noon to noon—is then coupled parallel to another one loaded by means of the load resistance, and then exchanged by throwing the resistance upon the former, the load upon the new dynamo. During winter two dynamos run parallel during several hours of the day, all three having been used simultaneously and in parallel so far only for trial. The first basement contains the three mercury switches (Fig. 7), actuated by hand, used for the three main cables.

Network.

There is only a primary high-tension network, the transformers being placed invariably in the houses of the customers. This primary network is represented by the accompanying table, whose numbers give the section of each of the concentric conductors forming the cables used. The insulation between the interior conductor and the lead cover below the concentric exterior conductor, and between this conductor and the double exterior lead cover, varies between 6mm. and 7mm. for the various sections employed. The cables are placed in wooden troughs, which

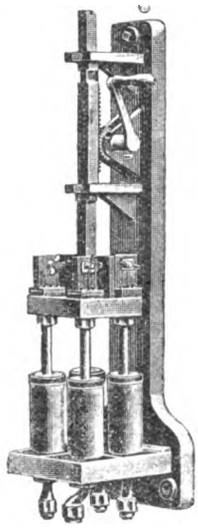

FIG. 7.—Mercury Switch.

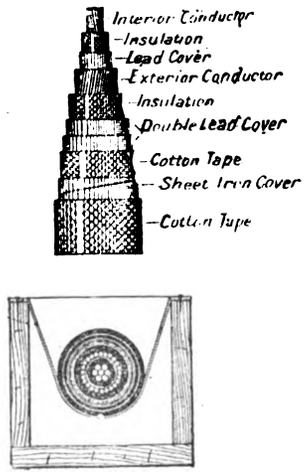

FIG. 8.—Details of Cable and Wood Trough.

are filled with asphalte, and are suspended within these troughs by means of iron hooks placed suitable distances apart (Fig. 8). The total length of the network is at present about 17½ miles. Its design is interesting in so far as it was one of the first networks to be thoroughly designed theoretically with regard to loss of pressure and distribution of currents *before* it was laid down or even ordered. Three feeder cables go from the station, each of ·340 square inch section, in each conductor. At the time of the first installation there were only two going to the point A (see Fig. 9). From this point, to which the loss would be found directly from Ohm's law, there spreads a complicated network with 10 closed meshes (marked by Roman ciphers). The distribution of the current for this network may be found exactly and with but a relatively small amount of labour, by means of the method of sectioning published by Messrs. Herzog and Stark, of Budapest, in 1892, and described, enlarged, and modified by Mr. Herzog and one of us in a special treatise upon the calculation of networks. This method is nothing but a physical interpretation of Kirchhoff's laws, and consists in placing one section per closed mesh at any point from which a customer is tapped; the consumption at this point may be zero, as at the points A, B, C, D (Fig. 9). For this point the sum of the arriving

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currents is (A + B + C + D), the sum of the leaving currents, or those arriving from the opposite side being (A + B + C + D). For the point G the customer on one side of the section is supposed to take G, the one on the other side taking (8·6 – G) amperes. Proceeding in this way, the whole network was changed into a set of open—*i.e.*, simple—branch lines, which are all in connection with the feeding point, A. For these open lines the total current distribution is easily found from Kirchhoff's laws: and the values found for the unknowns, whose number is 10, equal to the number of closed meshes, gives directly the intensity and direction of the unknown currents ending at or passing across the chosen sectioning points and the real position of these sectioning points for the given distribution of customers. In the present case the values of the unknowns were:

A =	91·0 amperes	.....	G = 41·2 amperes
B = –	92·5 amperes	.....	H = 5·3 amperes
C =	107·0 amperes	.....	L = 18·3 amperes
D = –	83·2 amperes	.....	M = 21·5 amperes
F =	11·1 amperes	.....	P = 80·2 amperes

The customers and their consumption are indicated by arrows standing vertical upon the conductor, the accompanying numbers showing the intensity in amperes; the numbers with circles give the lengths in metres divided by the corresponding sectional area in square millimetres, and the arrows parallel to the conductors, with their numbers, indicate direction and intensity of the currents in the respective parts of the network. Further details may be taken from the treatise mentioned; here it may suffice to say that the authors have modified the method, and have shown how to find from a sort of network ledger at once direction and intensity of current in any special conductor of the given network and for any distribution of the load. The accompanying figures refer to the maximum load of 602 amperes, corresponding to 24,000 lamps of 50 watts each; the corresponding losses are:

From A to *a*, 23·7 volts.
„ A „ *b*, 20·3 „
„ A „ *c*, 19·2 „
„ A „ *d*, 19·0 „

The method involves a large amount of mere calculating work, but this is fully repaid by the saving in the first cost, and by the splendid knowledge obtained with regard to maximum load of any special conductor, maximum loss, most favourable distribution of load, etc. England has been the place where the methods for calculating dynamos have been found out and improved. These admirable methods are rightly estimated very highly, but no English electrician would boast of not knowing or not employing them, though such boasting has been done in connection with the simple methods mentioned for calculating or studying networks.

(To be continued.)

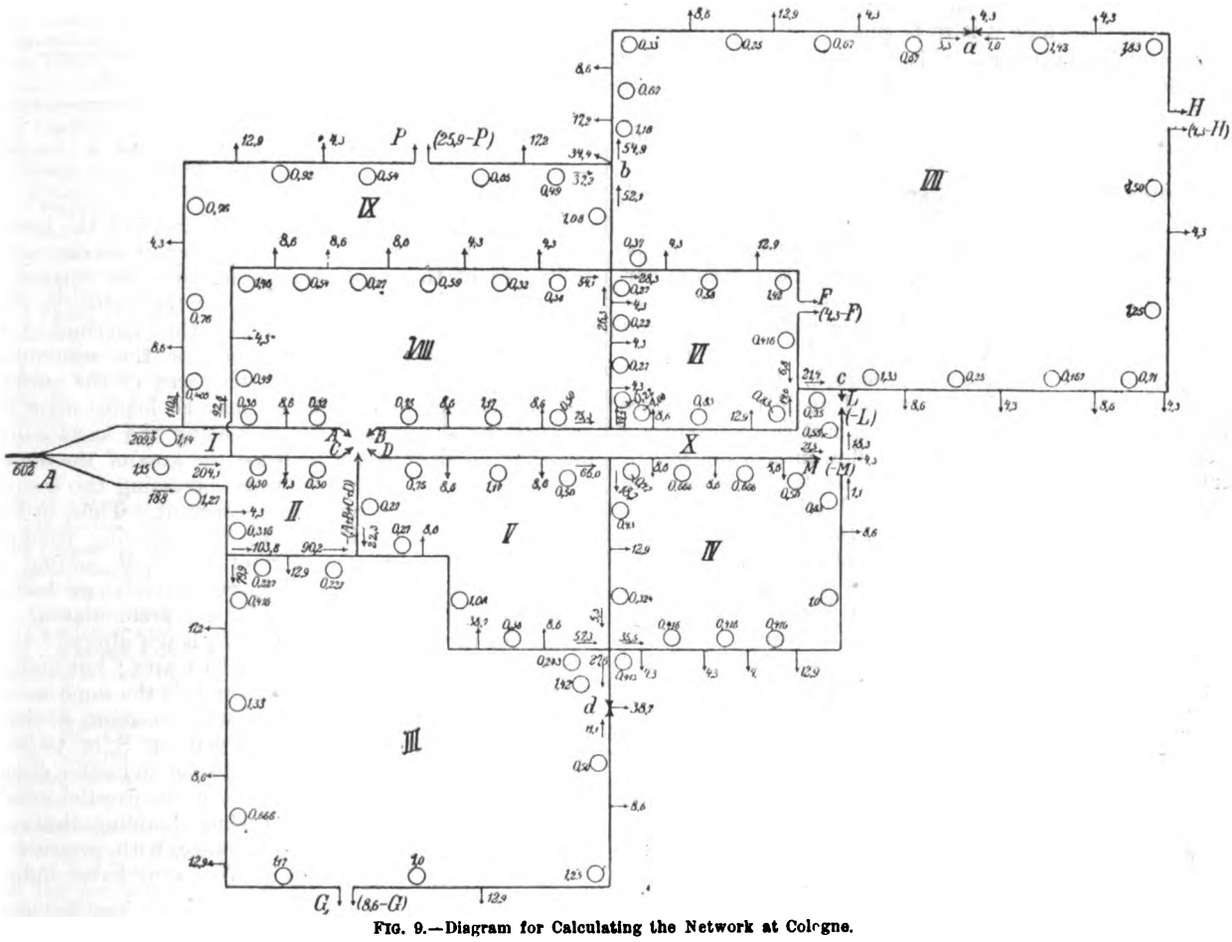

FIG. 9.—Diagram for Calculating the Network at Cologne.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXII.

(Specially Contributed.)

Practical Voltmeters.—These are of two kinds:

1. Closed-coil instruments.
2. Open-coil instruments, which we may call static instruments.

The closed-coil instruments are of the galvanometer or ammeter type, so that the description of a few typical instruments will answer our present purpose.

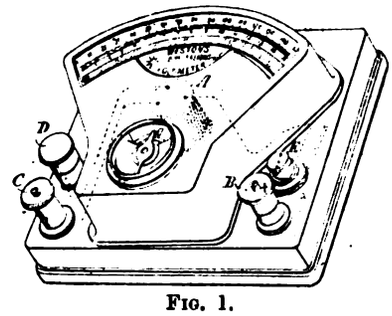

FIG. 1.

Weston Voltmeter.—This instrument is built upon the same principle as the ammeter previously described, except that it has a high-resistance coil of fine wire, A,

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(Fig. 1) placed in *series* with the moving coil *instead* of a low-resistance coil in *parallel* with it. The high-resistance coil is wound in two sections of different lengths and resistances. One section only can be used by making the connections with the binding screws, B D, or both sections can be used in series by making the connections with B C. This gives the instrument a wider range of usefulness. E is a key for contact-making.

Range of Instruments.—It has been pointed out that the instrument used must not invalidate the test; hence with regard, say, to ammeters, the resistance of the instrument must never be large compared with the resistance of the circuit. With regard to high-resistance coils, these must not be used with too large a current for fear of fusing; hence each class of instrument is only adapted for a certain range, outside of which there is danger to the instrument, or the test is fallacious. As a rule, all these closed-coil voltmeters are used but temporarily—that is, a key is pressed, or a switch is turned, and a reading taken—otherwise the heating effect would spoil the instrument. Ammeters are most often kept permanently in the circuit, because the instrument suffers no harm from the current. For the reasons stated, the same instrument will not do for all purposes, but each instrument must be adapted for the particular use to which it is to be put.

Hummel Voltmeter.—This instrument is constructed upon the same principle as the ammeter previously described. A slight modification has been made by Bain, in America, who replaces the soft-iron tube by a thin soft-iron vane.

Bardon's Voltmeter is, like some ammeters described, based upon the action of a solenoid upon a soft-iron core.

Open-Coil Voltmeters.—The three quantities to be electrically measured, as we have seen, are pressure, current, and resistance. We know from every-day observation that pressure may be exerted against a resistance without any motion occurring. A boy may push against a rock, but his feeble push does not move the rock. Electrically, we may have pressure exerting or exerted against a resistance so large that the pressure exerted is unable to produce a current flow, or at least any current flow measurable by our instruments. If, in Fig. 2, S represents any source of electricity, and A B two plates of conducting material connected to the source, S, as shown, the plates, A and B, may be looked upon as the terminals of the source, and the difference of potential, or the difference of pressure, or the E.M.F., whatever you like to call it, between A and B is the same as between the terminals of the source. The air space between A and B completes the electric circuit, and the resistance of the air space is too great to allow of current flow. Instead of current flow, however, we get something that can be measured, which we call *charge*.

FIG. 2.

Any electric circuit of the kind just described, where the ends of the conductors, or the ends of the conductors enlarged, are connected only through air, or some other non-conducting material in the place of air, is called an *inductive* circuit. In an inductive circuit, the phenomenon called *charge* takes the place of the phenomenon called current in the conductive circuit, and is subject to the same law, or say law similar to that of Ohm. For convenience of formulæ, let us use the term "accumulation" instead of charge, and signify accumulation by the symbol A.

In the conductive circuit

Current × Resistance = Electrical Pressure;

i.e., $C \times R = E$.

In the inductive circuit

Accumulation × Resistance = Electrical Pressure;

i.e., $A \times R = E$.

Instruments fashioned to measure A instead of C, and by this means to obtain the value of E, are called electrostatic instruments, or open-coil instruments. Before describing any of these instruments it should be mentioned that in the inductive circuit, as in the conductive, the point at higher potential or pressure is called positive, or indicated by the sign +, to the point at lower potential, which is termed negative, or indicated by the sign −. Of these instruments, Wiener says: "Since no current flows across the charged bodies, no useful energy is consumed by this electrostatic method of measuring electromotive forces, and since the static electric charge is independent of the temperature and of the influences of magnetic fields, the readings of an electrostatic voltmeter are most reliable. As the polarity of the charge changes simultaneously in both bodies in case of an alternating current, electrometers may be used for measuring alternating electric pressures, for which purpose they offer special advantages on account of the absence of coils of wire subject to induction currents."

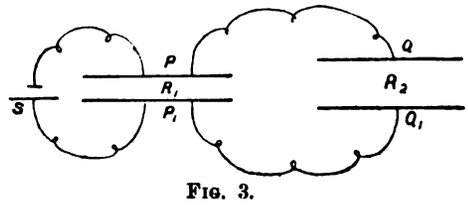

FIG. 3.

Let us consider some of the similarities of the inductive and conductive circuits. In the latter, if we decrease the resistance of the conductor we increase the current, with pressure remaining the same. So in the inductive circuit, if we decrease the resistance of the non-conductor, or dielectric, as it is called, we increase the accumulation, pressure remaining the same. The area of the surface of one of the opposing conductors may be looked upon as the area of the dielectric. By increasing the surface of the opposing conductors we increase the area of the dielectric and decrease its resistance, thus increasing the accumulation, with pressure remaining constant. Thus, in Fig. 3, if S is the source, P and P_1 the opposing conducting surfaces, by doubling the area of P and P_1, adding equal surfaces to each, as S and S_1 respectively, we halve the dielectric resistance and double the accumulation. The density of the accumulation on P P_1 is not altered—that is, the accumulation per unit of surface area; but under the new conditions the accumulation of S is the same as on P, the areas being the same and pressure constant, so that the total accumulation is that on P + that on S, or twice that on P. This addition of S to P in the inductive circuit is just the same as adding a second wire in parallel with the first in the conductive circuit, thus doubling the area of conductor and halving the resistance, with pressure constant doubling the current. We can have inductive

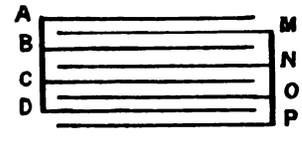

FIG. 4

resistances in series or in parallel, or a mixture of both, just as in the conductive circuit, and the same formulæ apply to the one as to the other, simply putting A in the place of C. It is convenient at times to have a considerable accumulation, just as it is convenient to have a large current, and then we modify our apparatus in order to get very large conducting surfaces opposite with very small dielectric resistances. Thus, if we take a large number of conducting surfaces, A, B, C, D, etc., and similar surfaces, M, N, O, P, etc., and oppose them as in Fig. 4, the ends of one set of surfaces, A, B, C, D, being in conductive contact as shown, similarly the ends of M, N, O, P with a dielectric such as air or paraffin between the surfaces, then the action of A, B, C, D is just as if it was one large

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surface opposed to an equally large surface equal to M, N, O, P. The dielectric resistance is by such means very much decreased, and the accumulation increased. An apparatus of this kind is called a condenser. A condenser, then, is a piece of apparatus wherewith to obtain large conducting surfaces acted on in the inductive circuit, with small dielectric resistance and large accumulation, or greater capacity. The formula,

$$A = \frac{E}{R},$$

is as comprehensive for the inductive circuit as

$$C = \frac{E}{R}$$

is for the conductive.

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 23.

SIR DAVID SALOMONS in the chair.

At last night's meeting of the Institution the following candidates were balloted for :

Foreign Member.—A. E. R. Collette, The Hague.

Members.—Francis Wm. Clements, Gentz Gasse 50, Vienna ; Patrick Walter D'Alton, Croom's Hill, Greenwich Park, S.E. ; W. Fearnside Irvine, Johannesburg ; George Robert Mockridge, Western Union Telegraph Company, Penzance.

Associates.—George Frederick Adcock, Riverdale, Bourne End, near Maidenhead ; Howard H. S. Baker, Westminster Electric Supply Corporation, Limited ; Edward G. C. Barton, Brisbane, Queensland ; J. Augustus Bauer, 86, Leadenhall-street, London, E C. ; Selsey A. Cartwright, 60, Dale-street, Lancaster ; Percival Bailey Clarke, 29, Great Percy-street, W.C. ; Valentine Corin, Anchor Foundry, Penzance ; A. T. Durrant, 4 Queen-street, Great Yarmouth ; Edmund Lewin Birkbeck Hill, 1, Broad-street, Oxford ; Charles Morison Johnston, Town Hall, Lancaster ; Horace Algernon Marler, 139, Petherton-road, Canonbury, N. ; W. H. Miller, 61, Loch-promenade, Douglas, Isle of Man ; William Moat, Johnson Hall, Eccleshall, Staffordshire ; Lieut W. Montgomery, R.E., School of Military Engineering, Chatham ; Edgar Williams Newton, 18, Gladstone-street, Hartlepool ; George A. Pearson, 28, St. Andrews, Norwich ; Charles Edward Peebles, 15, Nevern-square, Earl's Court, S.W. ; John Milner Shackleton, Canon Brook, Lucan, co. Dublin ; Alfred H. Shepperd, Superintending Engineer's Office, Post Office, Belfast ; Frederick Martin Short, Durban Lodge, Woodchurch-road, West Hampstead, N.W. ; Wm. Rowan Wilson, 75, Waterloo-street, Glasgow.

Students.—Benjamin Herbert Isidore Adler, George Frederic Lewis Alexander, and John Drayson Dymond, Faraday House, Charing Cross-road, W.C. ; William Frederick Bolton Bronavon, Stoneygate, Leicester ; Harold William Holder, Somerstown, Holderness-road, Hull ; Frederick Watson Joll, 90, Claverton-street, Grosvenor-road, S W ; Hugh Sebastian King, 8, South-villas, Camden-square, N.W. ; Algernon Lionel Lennox, Messrs. Easton, Anderson, and Goolden, Erith Ironworks, Kent ; Laurence Moore Peel, Moore House, Beckenham, Kent ; H. F. Platt, The Laurels, Kingdon-road, West Hampstead ; Gabriel Arthur Maddox Rosetti, Salford Rolling Mills, Manchester ; Edgar Stopford Saunders, 51, Clarendon-road, Holland Park, W. ; Harold Skipwith, 24, Kempsford-gardens, Earl's Court, W. ; Frederic John Thompson, Melrose, Teddington, Middlesex ; Victor Watlington, 10, Fairfax-road, Bedford Park, W.

The **Chairman** said it was only a week ago that they were met in that room in a joyful spirit to move a resolution tendering their services to Her Majesty to assist her in case of need to defend her throne and our country. In one short week those feelings of pleasure had been converted into those of woe. A cloud had come over the palace ; a very estimable and venerable sovereign, a good mother, and a good woman had lost her son-in-law, and a beloved princess of ours had lost in this world her husband. They knew well that when there had been a sorrow in this country, or in any other country, afflicting any number of people, or even a single person, Her Majesty had always been the first to sympathise with them in their grief. At such moments as this we as Englishmen and as men, quite apart from our nationality, joined our hearts to those of the Royal Family, to the Queen and Princess in their distress, to express our deep sympathy and grief with them in their trouble. He asked the meeting to pass a special resolution expressive of the great regret with which the Institution had received the news of the untimely death of H R.H. Prince Henry of Battenberg, and that the members desired to be allowed to lay before Her Most Gracious Majesty their expression of profound sympathy with the Queen and the Princess Beatrice in the great bereavement which had overtaken them.

Major-General Webber added a few words, and asked them to remember that it was in furtherance of the great wish to identify himself with the volunteer service of this country, to which he already belonged, that led Prince Henry of Battenberg to volunteer for the Ashanti compaign, so that he might have the opportunity of seeing some active, practical service in the field. He was a man who in late years they had learnt to regard with very great feelings of kindness.

The resolution was passed in solemn silence.

The discussion on "Wiring" was then resumed.

Mr. Geipel said he endorsed the opinion of Mr. Bathurst that it was undoubtedly the expense of wiring buildings which led to objections to the electric light. Those who were interested in electricity were doing their utmost to reduce the cost of supply, and the lamp-makers were doing likewise ; yet, to judge from the tone of the remarks at the recent Board of Trade conference, an attempt was being made by some of them to increase this cost of wiring by raising the standard to an unnecessarily high pitch. Do not let them saddle their work of wiring with more unnecessary conditions than they could help, but by all means they must protest against shoddy work. He regretted to see a tendency among engineers of the low-tension system to force a 200-volt supply upon the consumer, and contractors would do well to join consumers and protest emphatically against this practice until such time as absolutely reliable and cheap 8-c.p. lamps were obtainable for that pressure. He was afraid there was a notable absence of figures in the two papers as to first cost. He hoped the members of that institution and the fire insurance companies would not be alarmed as to the somewhat pessimistic remarks and warnings of Mr. Mavor as to the necessity of greater stringency. With regard to the casing, unless concentric wiring was about 50 per cent. cheaper he was afraid it would not help them. As to the soldering of all contacts, that necessitated a soldering iron, and there was not that objection with the ready-made mechanical contact. He agreed as to the importance of what Mr. Mavor described as grouping the branch fuses at distributing centres, and considered the method should be made compulsory, especially as it involved no increase in the first cost.

Mr. Hancock said he was not altogether sure that insulating the pipe and reducing the insulation of the cable was exactly the right thing. In the first place, by putting the insulation inside the pipe they reduced its capacity a great deal ; and in the second place, if the life of vulcanised rubber was only three years, he would like to ask if they allowed 33 per cent. depreciation.

Mr. McLean (Oxford) would like the question to be looked upon from the point of view of the central station engineer. At Oxford he might have six or seven installations going on at once, and he had to look after them all. If he neglected to do that and an electrical fire occurred his company's credit suffered and his own credit suffered. There were a number of very pretty things for exhibition on the table, but he thought he could show just as nice things with the old wooden casing. Under floors they would find all sorts of things were done however perfect the system they adopted might be in theory. As for what had been said on the subject of 200-volt lamps, he would like to see them, but he thought that if they turned a 200-volt current into some installations he knew of, the light would not be at the lamps, but somewhere else altogether. He was glad to see the clause in the new regulations of the Board of Trade that if the consumer's insulation fell below a certain point, the current should be cut off. The action of the insurance companies in proposing to raise the premiums on central stations was most unreasonable.

Major-General Webber agreed with this, and suggested that the insurance companies did not appreciate how the fire risk was lessened by installing the electric light. There were many large warehouses at the seaports where it would be to the advantage of the companies if they would encourage the introduction of the electric light by reducing their at present very high rate. In considering the various systems of wiring, open work must not be forgotten. In his own house some done very long ago had proved most satisfactory.

Mr. Langdon thought wood casing was good enough in the open but tubes should be used in hidden work.

Mr. Donovan having spoken, **Mr. Antill** referred to the satisfactory character of the open work at the British Museum, while **Mr. Campbell Swinton** spoke of the difficulty of contractors using more than one system with one staff.

The discussion was then adjourned to the next meeting.

WHAT, WHEN, AND WHERE.

Institution of Junior Engineers.

January 25, 7 p.m.—At the Westminster Palace Hotel, S.W. Anniversary dinner.

Electro-Harmonic Society.

January 31, 8 p.m.—At St. James's Hall Restaurant, Regent-street, W. Smoking concert.

Society of Arts.

January 27, 8 p.m.—At John-street, Adelphi. Cantor lecture, by Dr. J. A. Fleming, F.R.S., on "The Construction of the Transformer." Lecture II.

January 29, 8 p.m.—Eighth ordinary meeting. "Standards of Light," by W. J. Dibdin, F.C.S.

Institution of Civil Engineers.

January 28, 8 p.m.—At Great George-street, Westminster, S.W. "Recent Developments in Gas-Engines," by Dugald Clerk, A.M.I.C.E. Discussion.

Physical Society.

January 24, 5 p.m.—At Burlington House. 1. Exhibition of geometrical instruments by E. Scott and Signor Monticolo. 2. "Resultant Tones," by Prof. J. D. Everett. 3. "Experiments with Incandescent Lamps," by Sir D. Salomons.

Liverpool Engineering Society.

January 29.—At Adelphi Hotel, Liverpool. Annual dinner.

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DR. HOPKINSON ON METHODS OF TEACHING.

It is now many years since the tripos list was issued with the name of Hopkinson as Senior Wrangler, but the time is vividly recalled to our memory because a relative of the Senior Wrangler who was full of the idea that the promise shadowed forth by the position of the student would be amply fulfilled in practice in years to come rushed into our room with the welcome news, and, in fact, was as excited over the success as friends usually are. The promise has been fulfilled, for there is no more sounder theorist, no more prominent practician whose speeches and papers command greater attention than Dr. Hopkinson. A second time his colleagues have elected him to the presidential chair of the Institution, and his inaugural address is before us. It deals with a question which is all-important, and though others have laboured in the same direction their efforts could not expect to obtain the sanction and authority which necessarily clings around the words of so eminent a man as the President of the Institution. Many years ago, out of curiosity we examined a number of school-books issued at various periods from the beginning of the century and the time of examination, somewhere about the year 1876, and found that practically author had followed author, each treating his subject in the same manner; and ofttimes the paragraphs in the earlier books were to be found in almost identical words in the later books. The books examined were electrical books, but the reason for examination was to discredit the system by which every publisher of school-books seemed to want to issue a book on every conceivable subject. No doubt the publisher is right from his business point of view, but we then held, as we now hold, the multiplication of books containing the same information in almost identically the same manner to be an evil rather than a blessing. If an author has something new to say, or a simpler way of saying it, by all manner of means produce a book. We do not care one rap if nine-tenths of the work follows old lines; the new will commend itself and sanction the publication.

We are sorry that Prof. S. P. Thompson should have thought fit to call attention to his lectures, because if any man at the present time is answerable for the course pursued generally in teaching the subject, and condemned by Dr. Hopkinson, that man is Prof. S. P. Thompson. His "Elementary Lessons in Electricity and Magnetism" must be taken to express his views as to the course to be followed in teaching, and the first chapter of that book deals with "frictional electricity." Referring to this book in our issue of March 29 last year, we said "we entirely disagree with his teaching in the earlier lessons of this book." The most eminent men cannot expect to know every subject, and most emphatically Prof. S. P. Thompson is not to be congratulated upon his knowledge of "frictional electricity." Now that he hastens to admit Dr. Hopkinson's contention, we trust he will change the contents of the first part of his book in future editions. As regards Prof. Ayrton's book, "Practical Electricity," it hardly comes into the category of an ordinary school-book.

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Each of these authors has something new to say and a new way of saying it, so that their books are welcome. In America a few authors have cast aside the old ways and started on lines very much like those suggested by Dr. Hopkinson. He, though not in so many words, says that theory should be taught from practice, and that the historic development of the subject is a waste of time. Nine-tenths or more of the views held even fifty years ago have been swept aside by the wonderful practical developments of the past quarter of a century. As improvement has succeeded improvement in the workshops, all of us have had to more or less modify our views to meet the new requirements. Dr. Hopkinson points out that the practical applications of electricity are from the discoveries of this century, and that these are almost wholly connected with what we may call current electricity and not with static electricity; hence the science should be taught through current electricity rather than through the antiquated notions about frictional or static electricity. Dr. Hopkinson sums up his views in the following pregnant sentences, which we trust will be re-echoed by every teacher in the kingdom, and that a real effort will be made to give effect to views undoubtedly correct: "There can be no doubt that the science could be easily rearranged, and that the phenomena of electromagnetism could be made fundamental, and that the facts concerning permanent magnets could be made subsidiary thereto, exactly as we have deduced this evening the facts of electric attraction from the phenomena of current electricity. I believe that in the future this is the way the science must be arranged for practical men. They are but little concerned with the attractions between charged spheres and the like, and very much concerned with the laws of currents and differences of potential and capacities. The theory of permanent magnets has for the modern electrical engineer only a general interest, but the laws of magnetic circuits and induction therein are all-important. It would seem that the subject needs rearranging, and that that which is most important should be put prominently forward. I even venture to think that this would be no loss to pure science; we should see with increased clearness how little we know what electrical phenomena really are, and how much we know of how electrical laws work. We shall see how much there is that is arbitary and conventional, and by no means absolute, in the system of units we have adopted. The science of electricity is so essential to the practical electrical engineer that it should be arranged so that he can learn in logical order what he most wants to know."

SOUND CASTINGS FOR ELECTRICAL WORK.

BY WALTER J. MAY.

Although, as a rule, electrical engineers are not much concerned with foundry work, they yet have very considerable interest in having sound castings for many of the appliances used in their work, and freedom from outside faults such as "blowholes" or flaws is not the only thing necessary. To have iron possessing equal resistance or conductivity—it matters little from which point our deductions are made—it must be of the same texture throughout, and should possess the same degree of homogeneity in all parts after the skin of the casting has been removed, and to secure this the iron must be clean. The writer uses more or less scrap iron for fine castings, and often has parts of electrical machinery sent in. As a rule these are good castings so far as outside appearance and quality of iron may be concerned, but many show that the iron is not too clean when broken, very many fractures showing that some amount of sullage or slag is in the iron, and this very largely alters the structure of the metal. Great care is no doubt taken in the foundries to ensure as uniform a quality in the metal as possible, but still the almost impossible removal of the sullage or dirt does not in all cases appear to be overcome.

Practically speaking, all small castings, or those having small or complex parts, have to be poured while the metal is very hot, this being done to secure fluidity; and, needless to say, there is no time lost in transferring the molten metal from the cupola to the moulds, as otherwise it would not run with sufficient freedom to fill all interstices of the moulds. This renders it very difficult to get the metal clean and free from sullage, and the result is that the casting is not of equal texture throughout. Although difficult to deal with, yet this point is one which is not insurmountable, as given time in which the sullage can rise while the metal retains its fluidity, the whole mass of metal becomes of even quality, and no trouble as to difference of structure will occur. To secure the necessary fluidity, metallic lead is sometimes used, while in some other cases aluminium has the preference; but neither give such good results as ferro-sodium, as this latter both increases the fluidity of the molten metal and by its action brings the whole of the dirt and sullage to the surface of the ladle, where it is easy of removal. The action of ferro-sodium is to maintain the metal in a more hot and fluid state than could otherwise be obtained, and time is thus gained in which the purification of the metal can take place, which is by no means an unimportant factor.

In the resultant castings made from iron fluxed with ferro-sodium it will be found that the iron is kept clean and uniform, and that externally it is free from blowholes or flaws of any kind. It can be filed, turned, or otherwise tooled with the greatest facility. In fact, ferro-sodium is just *the* thing for engineering castings of all kinds, and particularly for electrical castings.

Being a comparatively new fluxing medium, it may be well to mention that its cost is small, and would not in any way increase the cost of the castings. There being fewer wasters made, the balance would be in favour of the iron-founder rather than against him, as in all foundries wasters form a very considerable item of expense, and often delay in the delivery of the work.

THE ARC LIGHT.*

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S.

LECTURE II.

(Concluded from page 74.)

The Trotter Phenomenon.

I now come to the most recent and by far the most important of recently-discovered arc phenomena. Mr. A. P. Trotter has observed a phenomenon in the arc which has so completely changed one's ideas as to the nature of the crater surface, that one needs to reconsider everything previously learnt or observed.

When you project upon the screen by means of a good acromatic lens (such as a camera lens) an image of the arc, and adjust it so as to get a good view of the crater, a little care will enable you to discern, as often as not, somewhere in the middle of the luminous crater—not always exactly in the centre—a nebulous patch, sometimes extending in different directions. This patch is more luminous than the surrounding surface of the crater, over which it moves in a capricious way. Sometimes you can catch a glimpse of this patch revolving, flickering round and round; sometimes it goes round one way and sometimes the other. You cannot readily observe it, however, unless you resort to artificial means, because of the rapidity of its motion. So to see it you must have recourse to the stroboscopic method. Take a simple disc of cardboard 8in. or 10in. across. Cut in this a number of equidistant narrow radial slits—say 36, 48, or

* Cantor lectures delivered before the Society of Arts.

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60—and blacken the disc to obviate stray deflections. Put a pin through the centre, and fix the pin into a wooden handle. Spin the disc by hand, and watch the arc through the slits. You will then, at moments when the frequency at which the discs pass the eye corresponds to the rapidity at which the movements in the arc occur, catch sight of the moving object. A second method, suitable for projection of the phenomenon on the screen, is to mount a similar disc upon a small electrically-driven motor right in front of the arc. A suitable frequency is 400 per second or so. A third method of observation consists in throwing the image of the arc not upon a stationary screen, but upon a revolving disc painted half black, half white.

By the use of each of these methods Mr. Trotter succeeded last summer in proving that in the arc there is a phenomenon of rotation of something the precise nature of which is not yet known. The discovery was communicated in due course to the Royal Society. The essence of the stroboscopic method is that it gives a stationary or slowly moving view of a rapidly moving object. If a thing is revolving so fast that the eye cannot follow it, it may be readily seen if the observer is furnished with an apparatus which will allow the eye only to catch a momentary glimpse once in each revolution. Suppose that just at the instant when one slit passes the eye the revolving thing is in a certain position, and that by the time the next slit has come opposite the eye, the revolving thing has gone exactly once round, the eye will see it as though it had not moved. If the frequency with which the slits pass the eye does not precisely correspond, the revolving object will seem to revolve slowly, either forward or else backward, according as the frequency is either too small or too great. The thing that Mr. Trotter has found in the arc is a white object, having a sickle-shape or comma-shape, extending from some place near the middle of the crater to its edge, and revolving in a singularly capricious manner. The wandering whitish spot that is seen without the use of any revolving discs is apparently the head of the comma-shaped object, the tail of which moves usually so fast that its form cannot be seen, except by the use of the revolving slits.

By the kind co-operation of Mr. Trotter I am able to show you this rotatory phenomenon. An arc lamp arranged to be hand-fed is enclosed in a box. In front of the lamp is a small lens to throw an image on the screen and immediately in front of the lens is a rotating disc of tinned iron, provided with slits, mounted upon the shaft of a small but rapidly revolving electric motor. The slit disc as it revolves cuts off the light and restores it intermittently. We can vary the intermittences from 200 to 400 per second by changing the speed of the motor. What we have to do is to project a well-formed image of the crater upon the screen, and watch it while the rotating disc gets up speed, until the right speed is attained. We then see a sickle-shaped white patch (Fig. 20), which appears to rotate

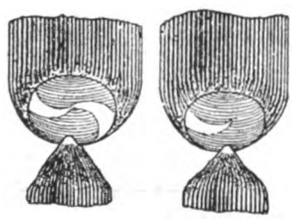

FIG. 20.

slowly backwards or forwards about a point as centre, or to stand still, according as the rotating slits go too quickly or too slowly, or keep in perfect synchronism with it. It usually has its centre in the middle of the crater surface, and extends to the edge. It is at the present moment in very rapid rotation; now it apparently decreases its speed, and stops for a moment, so that its shape is clearly visible. It appears as though the luminous part of the crater were shaped like the blade of a chaff-cutter, and whirled round with great rapidity. Now it changes its direction, and goes too quickly to be visible. Sometimes, when the speed of rotation of the object on the crater surface is only half as great as the speed of the disc, you get two views of the sickle-shaped object at opposite sides, forming a double figure (Fig. 20); and sometimes one gets a treble appearance or even four sickles meeting like a star in the centre. Supposing you have the rotation well developed, and then alter the current gradually, the speed changes in a perfectly regular way; and yet supposing there is a given current and the thing is going round at one particular speed all of a sudden, without any warning whatever, the direction of the rotation may reverse and yet keep the same rotary speed. When it reverses its direction of rotation it reverses its form also, the concave edge being always the advancing one. That is one of most puzzling things in the whole phenomenon. Apparently, with each current there is a particular speed of rotation that corresponds. The rotation is not a mere optical phenomenon of the surface of the crater, for, taking a lateral view of the arc and examining the flame part between the crater and the peak, Mr. Trotter has found evidence that the flame is itself, from top to bottom, also in a state of rapid rotation corresponding to what one sees in this white sickle-shaped body going round on the crater surface.

Interesting and puzzling as the Trotter phenomenon is, I fear it puts an end to the hope that the crater of an arc lamp might be used as a standard of light.

RECENT OBSERVATIONS BY MR. CROMPTON.

Mr. R. E. Crompton has lately noticed another arc phenomenon which was previously unknown, unless, indeed, it has been casually observed without the reason for it being known. It is the following: An arc may be burning perfectly steadily—of the proper length—everything going on without the smallest hint of any discontinuity, and all of a sudden, for apparently no reason whatever, the arc will enlarge itself, flaming out sideways, and the flame will go up round the upper carbon, and lick round it once or twice, and then everything will resume its former condition. Mr. Crompton observed this under the following circumstances. In order to study the feed mechanism of different lamps, and to find out which was doing its duty best, and also to study the properties of carbons with a lamp of any particular mechanism, he took records with a recording voltmeter of the difference of potentials between the carbons of the arc, and obtained a very large number of curves. If a recording voltmeter is put across the terminals of a lamp and the feeding mechanism sticks, you have a record of the fact by a slight kick in the curve. If the feeding mechanism stops and the feed does not take place when it ought to do, the arc will lengthen unduly, and the voltage across will rise, and that rise will go on for some time until the feeding mechanism does choose to work. As a general rule, a feeding mechanism which waits too long feeds too much. It overfeeds because it has waited too long, and down comes the voltage suddenly, causing a deal of irregularity before the steady condition of things is resumed. All this will be duly recorded in the irregularities of form of the curve drawn by the instrument. With a more perfect arrangement of feeding mechanism, you will have comparatively small changes in the voltage. Records of this sort enable an engineer to pick out that particular mechanism or to find the particular adjustment of mechanism which will give the most equable voltage on the lamp, and, therefore, obviously will cause the lamps to burn with the least flickering. Thanks to Mr. Crompton's kindness, I have here a number of these records. In this case the records are taken, not from a variety of lamps with different feeds (good and bad), but from a single lamp with a good feed. The object of this particular set of records was to study the different qualities of carbon in the same lamp. The first record shows a very even line; there are very slight undulations upon it; the feed was doing its duty; the carbon has got burnt down to a short stem and the rod had descended as far as the stop would allow it to; the arc became too long; the flame burnt itself out; the potentials rose until the arc broke, and the record stops in the middle of an up-stroke. The next record shows the same quality of carbon in use, but with two strange differences from the previous one. There are a number of small details which indicate that the feed was taking place at more or less regular intervals. It is a very fair curve, with a number of little nicks in it, which show that the feed had taken place rather more markedly than usual; but at two places in this record there is a great disturbance. In the middle of the comparatively quiescent line there is a sudden irregularity, which then settles down. Now, a great disturbance like that may be due to the following circumstances. The particular kind of carbon used was one which had certain impurities in it. All carbons have impurities, but this appears to have had impurities of a particular kind, whether silica, lime, iron, or what, I do not know. When the carbons were examined the following peculiarity appeared: Behind the crater, right up at the wide part of the conical surface, there accumulated, as there usually does accumulate upon the carbons of arc lamps, a brownish dust. In the present case, as soon as a sufficient quantity of dust had accumulated upon the base of the cone, the arc suddenly spread upwards, and like a good housemaid swept off the dust with a tongue of flame and then subsided, waited until a further aggregation of dust had accumulated, and then went housemaiding again. Among these records, several of which show this same phenomenon, there are some curious things, one of which illustrates the suitability or otherwise of a particular kind of arc lamp for use in a particular kind of building. In one case, where there are a number of cases of slight overfeeding, the record suddenly becomes very quiet indeed, the curve from that moment onward becoming almost a uniformly straight line. The record is marked as follows: "A to B tea-time, nobody walking about overhead." The lamp was suspended by a cord over a pulley, and the vibration of the building had caused the feeding to be a little irregular at times; but when there was no vibration the feed was more regular. It is not with all lamps that this occurs. Some lamps burn better in a building where there is little vibration to joggle the feed and prevent it waiting too long. Again, if a lamp is set to work at a certain voltage and then you use it at a voltage that is wrong,

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you get irregularity. Here, for instance, is a lamp of which the record at 40 volts is a most beautiful straight line, there is hardly the slightest irregularity, but the same lamp worked at 52 volts across the terminals is highly irregular. There is a regularly recurrent irregularity in the action of the feed at this higher voltage. Again, another fact Mr. Crompton has observed by following out these records—viz., that if carbons are left in a damp place where moisture can be slowly and regularly imbibed into the pencils, such a carbon, even although of good quality, may give rise to great irregularities. Here is a very irregular record, for instance, obtained from an extremely good carbon, one of Hardtmuth's make. That same carbon taken out and dried in a stove above steam temperature for two days gives a record which has not a flaw in it. Apparently the warmth of the hot air ascending up from an arc is not sufficient to drive out from a carbon the moisture which has been slowly accumulating in it. It seems to be very necessary if you would have an arc burn with great regularity to keep your store of carbons in a dry place.

But this topic does not strictly belong to the optics of the arc—it relates rather to the question of the mechanism of lamps, which is the subject for my next lecture.

LECTURE III.

Mechanism of Arc Lamps.

In the six years that have elapsed since I had the honour of reading a paper on this subject before the Society of Arts in March, 1889, a great deal has been done to develop the mechanism of arc lamps. On that occasion there was circulated among the audience a schedule of the various parts of the arc lamp, or, rather, of the various things for which mechanism has to be provided. This schedule is now reproduced in a more extended form :

Schedule of Particulars of the.....Arc Lamp.

Nature of Supply..... ;
.....amperes ; .....volts at terminals.

Resistances.—Main circuit coil,.....ohms.
shunt coil,.....ohms ; cut-out,.....ohms.

A	Driving power	.....
B	Kinematic train	.....
C_1	Striking (electrical)	.....
C_2	,, (mechanical)	.....
c	,, adjustments of ...	.....
D_1	Feeding (electrical)	.....
D_2	,, (mechanical)	.....
d	,, adjustments of ...	.....
E	Moderating	.....
F	Replacement	.....
G	Focussing	.....
g	,, adjustments of...	.....
H	Change over	.....
I	Cut-out.....	.....
K	Cut-in	.....
L	Path of main circuit	.....
M	Path of shunt circuit.....	.....
N	Carbon-clamps	.....
O	Globe fittings	.....
P	Special features	.....

A few words of explanation are needed as to the meaning of some of the expressions used. By "kinematic train" is meant the particular mechanical device that holds the carbons from feeding until freed at the proper time. "Moderating" mechanism is instanced by the dashpots and the fan governors found in some lamps. "Replacement" refers to such arrangements as there may be for replacing the carbons when burnt out ; "change over" to the mechanism for bringing a second pair of carbons into play.

In nearly all modern lamps gravity is used as the driving power. The weight of the upper carbon in descending, or that of its rod or attachment, is in almost every case the motive power in the lamp for propelling the parts. The kind of mechanism or kinematic train that is employed seems to be gradually simplifying itself. In the former paper the typical varieties of mechanism in use were considered in detail. There was the rack, and the train of wheels driven by it ; there was a method of having a clutch or a clamp on a carbon-rod ; there was the method of employing a brake-wheel, or a clutch-wheel, so common in English lamps ; there was the method of feeding by means of a screw which could propel the carbons towards one another, or separate them ; there was the cord and pulley. Also there were certain other more special motions ; for instance, one very beautiful one, using a small electric motor to drive the carbon. Then there were various ways of arranging the "feed" to take place by vibration, or by some periodic action similar to the striking or chiming mechanism of the ordinary clock. There were attempts at making continuous feeds, so that the carbons should always be in motion slowly approaching one another, all the regulation needed being effected by the lamp itself, which altered the speed to make it a little quicker or a little slower when necessary. Then there were some hammering feeds employing a method of propelling the carbon, or something that held the carbon, by definite blows through the clutch which held the carbons apart. All these mechanisms persist, but some are much more favoured than others, in the lamps that have been introduced since that time.

Some Early Arc Lamps.

It may be convenient here to introduce a picture or two relating to the mechanism of lamps in general. The first will be a very old one, an invention of W. E. Staite, a man whom the electrical profession has never recognised as he deserves to be—one of the pioneers on the whole subject of electric lighting, and inventor in 1846 of the first automatic mechanism for regulating the arc. Staite produced not one but something like a dozen different forms of mechanism for lamps. In 1867 he had an arrangement equivalent in principle to some of those mechanical devices which have found favour of late. He fed the lamp from the bottom. The lower carbon was caused to be lifted up either by a weight going over a pulley with a cord fastened at the bottom or by a float. Fig. 21 shows the rod

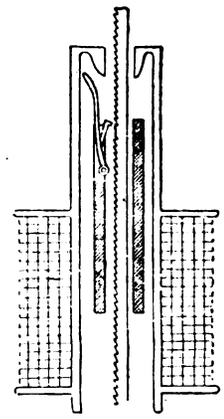

Fig. 21.

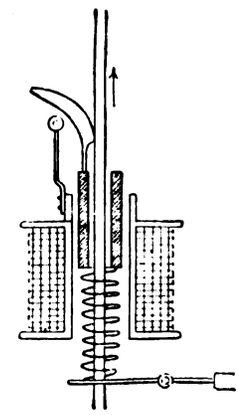

Fig. 22.

for holding the lower carbon, with ratchet teeth cut in it. These teeth are caught by a pawl pivoted to the top of an iron tube which surrounds the rod, the whole being surrounded by a series coil, which, when actuated by the main current, sucks down the iron tube against the constant upward force. As the carbon burned away and the current diminished by reason of the arc lengthening the tube slowly rises, and, of course, with it the clamp with its carbon. Presently the extension of the pawl is pressed against the inclined plane at the top, releasing the clutch, and the lower carbon is moved upwards. Another somewhat similar device which Staite had in 1852 is worthy of notice. In this case (Fig. 22) there was also a tubular core sucked down into a solenoid, the core being absolutely supported by a spring and a balance-weight. The rod passing through it was clamped by a peculiar clutch, the tail of which caught against a little wheel. The current in the coil, when turned on, pulled this down, pressed the curved arm against the wheel, and therefore pressed one end against the rod, and drew the rod down a little bit, so striking the arc. When the current in the main circuit became weakened, the curved brake-piece rose and released the carbon, which was allowed to slip up a little bit and feed the arc. It is a complete foreshadowing, only upside down, of some clutches which have been used in quite recent years.

(To be continued.)

INAUGURAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.

BY DR. JOHN HOPKINSON, M.A., F.R.S., PRESIDENT.

(Concluded from page 69.)

Let two plates of platinum dip into dilute sulphuric acid ; connect one plate by means of a wire to the zinc pole of a battery, the other plate to the copper pole. So soon as the connections are made, chemical reactions occur in the cells of the battery, the connecting wires are more or less heated, and, further, a reaction occurs in the vessel in which the platinum plates dip, the water is decomposed, gases are liberated on the two plates ; if these are collected, it is found that the gas from the plate connected to the zinc pole is hydrogen, that from the plate connected to the copper is oxygen. The effects cease on detatching either wire from the platinum plate or the pole of the battery, or otherwise interrupting the continuity of the circuit. In this experiment is seen a chemical reaction liberating energy in the cells

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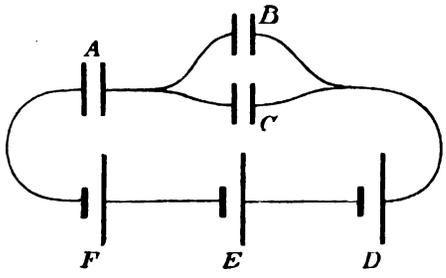
of the battery, and another chemical reaction absorbing energy in the vessel containing the platinum plates. How the energy passes from one vessel to the other we do not know.

The experiment may be varied. Let two plates of zinc or other metal dip into a solution of salt of zinc or other metal, and let the plates be connected to the poles of a galvanic battery for a time. If the plates be weighed before and after the operation, it is found that the plate which was connected to the zinc pole has gained in weight, and that the plate which has been connected to the copper has lost an equal amount. By weighing such plates, and noting the time the experiment was allowed to continue, it is practicable to examine quantitatively the phenomena of a galvanic circuit. Such pair of plates and solution of salt is called a "voltameter."

Suppose now a series of voltameters, having in each the same metal, are connected together in a chain, a plate of one to a plate of the next, and the two ends of the chain connected to the two poles of a battery, it is found that, no matter what be the size and form of the voltameters, their position, or the arrangement of the connecting wires, there is the same gain and loss of weight of the plates in all the voltameters; it is further found that, if the zincs of the cells of the battery are weighed before and after the experiment, and if the metal used in the voltameter be zinc, the quantity of zinc dissolved is the same in all the cells, and is the same is that transferred in each voltameter. The rate of dissolution and deposit is the same in the several voltameters and cells. In a closed galvanic circuit we have, then, a measurable something the same for all cross-sections of the circuit, measurable by the quantity of zinc or other selected metal which is transferred from one plate to the other of a voltameter in a unit of time. This something has direction as well as magnitude, and as the magnitude may be represented in terms of any unit chosen by a numerical quantity, C, so the direction may be represented by the sign + or −. It is arbitrarily chosen to take as + the direction from the plate which loses weight to that which gains weight through the liquid in the voltameter. The quantity, C, taken with its sign, is called the galvanic or electric current round the circuit, but it must not be supposed that it is known that there is anything flowing round the circuit.



Suppose that, instead of a simple galvanic circuit, the circuit divides or branches as indicated in the sketch, in which A, B, C are voltameters, F, E, D the battery. It is found that the quantity of zinc moved in B, together with the quantity of zinc moved in C, is equal to the quantity moved in A. This gives us the idea of current in the branch B or C, and we may say that the current in A is the algebraic sum of the currents in B and C. Not all bodies are competent to complete a galvanic circuit. Thus, if the copper wires which serve to connect the poles of the cells of the batteries and the voltameter are any of them replaced by thread, the phenomena of galvanism do not occur; if one of the wires be severed and a piece of paraffined paper interposed, the phenomena do not occur. Thus we have a distinction of substances into those which are capable of forming continuously part of a galvanic circuit and those which are not; the former are called "conductors," the latter "non-conductors." The distinction will be found to be really one of degree.

Consider a wire forming part of the galvanic circuit: after a short time no change occurs in the wire; it is heated by the current, and it loses heat by heat conduction, convection, or radiation. It is possible by the methods of calorimetry to measure the total quantity of energy leaving the wire as heat by these agencies; it must be equal to the quantity of energy brought into the wire by galvanic agency. Again, consider the battery itself. A certain chemical reaction is going on; zinc is being oxidised, and other reactions are occurring. Of the net amount of energy liberated per second by these, some goes to heat the battery, but some also appears in parts of the circuit external to the battery—that is, leaves the battery by galvanic agency. Thus a galvanic current is an instrument which takes energy from certain parts of the circuit and takes it into other parts of the circuit; and when the current is steady the algebraic sum of the quantity of energy taken into all parts of the circuit is nil. Denote by E C the quantity of energy per unit of time taken into any section, A B, of the galvanic circuit, the positive direction of the current being from A to B. If the whole of the circuit be broken into sections, the algebraic sum of the values of E C is nil, but the value of C is the same for all sections, hence the algebraic sum of the values of E is nil. Let there be any quantity, V_a, referred to each point of the circuit, such that $V_a - V_b = E$, the condition that the sums of the values of E shall be nil is fulfilled. E is therefore properly described as the difference of two quantities, one peculiar to A, the other to B; it is called the difference of potential between A and B, and V_a is called the potential at A, though it is only with differences of potential that we are concerned. Suppose now the circuit divides at A into two or more branches, joining again at B: by our definition the difference of potential between A and B is the sum of the energies taken per unit of time into the conductors, A B, divided by the sum of the currents in the conductors, A B. We have now to show that the energy taken into each of the conductors, A B, is equal to the difference of potential between A and B multiplied by the current in that conductor. This is by no means obvious, but depends on an assumption of an experimental truth—viz., that in a given conductor the energy taken into it by the current is a function of the current only, and is independent of other conditions external to the conductor. Granted this, it easily follows that if two or more conductors be joined at A and B, the potential difference between A and B deduced from each will be the same. As we have defined difference of potential by means of work done in a conductor when a given current exists in it, the laws of resistance must have the same basis. In the case of a homogeneous metallic conductor under given constant physical conditions of temperature, stress, and magnetic field carrying a constant galvanic current, C, Joule found that the heat liberated per unit of time varies as the square of $C = R C^2$ when R is a constant relative to C for the conductor. Whence follows that $E = R C R$ is called the electrical resistance of the conductor. For metallic conductors R is constant, but the constant R does not exist for all conductors; for the electric arc, for example, the heat generated varies more nearly as C than as C^2, and therefore E is more nearly constant than varying as C.

We have now gained two fundamental ideas—that of galvanic current and difference of potential. In terms of what units are we to measure them? We have only one unit to choose, because E C must be expressed in terms of our mechanical unit of power. If a unit were to be fixed at this stage, it would be natural to define either a unit of current or of resistance the ratio of $\frac{E}{C}$. For example, we might say the unit of current shall be that current whereby a unit weight of distilled water is decomposed per second; or, we might say, let the resistance of a piece of wire of defined shape and material at a definite temperature be the unit of resistance. The units in general use have an electromagnetic basis, but be it observed that all rational systems must be such that E C is expressed in some ordinary mechanical units. We have supposed that galvanic effects are measured by chemical change, and that the rate of galvanic effect—or, as it is generally called, the electric current—is measured by the rate of chemical change. From a theoretical point of view it would be possible to thus measure electric currents; but for practical purposes other means are adopted—electrometers, galvanometers, electro-dynamometers, and the like. With a description of such instruments and their methods of use I have not the time to concern myself this evening. We must assume that we have the means of measuring C, the galvanic or electric current so called, at any instant, and E, the difference of potential, whether these be great or small, and with any desired accuracy.

We should now be in a position to give a detailed account of galvanic batteries and of electrolysis, and the theory of the distribution of currents in systems of conductors of any form, and we are in a position to place the theory of thermo-electricity upon a thermo-dynamic basis without the introduction of any fresh idea. These, however, I leave on one side, and hasten to consider how the phenomena of electrostatics can be based upon what we have been discussing. There is a broad group of facts very familiar to the practical electrician engaged in laying telegraphic cables of which I have as yet given no account: I refer to the phenomena of capacity. Let us examine a little more closely the statement that I made, that if a slip of paraffined paper were interposed between the two parts of a conductor no electrical action would occur. Suppose that, instead of paraffined paper interposed between the ends of a wire, we have a very large number of sheets of tinfoil separated from each other by paraffined paper in such wise that we have a great area of tinfoil connected together, and separated from another great area of tinfoil by nothing more than the paraffined paper. If now these two areas of tinfoil are suddenly connected to the poles of a galvanic battery, we find that it is by no means true that no galvanic effect will ensue; we find that a galvanic current exists, but that, whilst it begins with a large quantity, this quantity goes on diminishing until, barring the slight imperfection of insulation of the paraffined paper, it becomes nil. We find, hen, that it is not true to state that paraffined paper cannot

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form a part of a galvanic circuit; it can form a part of a galvanic circuit, but it does so under completely different laws to the metallic conductor. With the metallic conductor the difference of potential at its two ends depends only on the current which then exists in that conductor, and not at all upon the currents which have previously existed; with paraffined paper, on the other hand, the difference of potential between the sheets of tinfoil depends not at all upon the then current, but entirely upon the currents which have existed since its two coatings were connected together, and the times for which they have existed. A galvanic current may be measured by the rate of electrolysis; being measured by a rate, its time integral will have a perfectly definite meaning, and will be measured by the total quantity of substance which would be decomposed in a voltameter in the circuit. We find that the difference of potential between the two coatings of the paraffin condenser is proportional to the time integral of the current since the time at which the coatings were connected together last. The constant ratio of this time integral of current to the difference of potential is called the "capacity" of the condenser. Suppose now that the condenser has been connected to a galvanic battery and the time integral of the current has been measured; let now the coatings of the condenser be disconnected from the battery and be connected together through any instrument for measuring the time integral of current: if this is accomplished with sufficient rapidity for loss by imperfect insulation to be negligible, we find that the time integral in the second case is equal and opposite to that which it was in the first. Here, again, is a difference from conduction in the ordinary sense. If a conductor in which a current has existed be disconnected from the source of current and be connected to any measuring instrument, no return current will be observed. Here, then, we have a new order of facts presented in an extreme case, but, in fact, applicable to all kinds of insulators. Suppose we diminish the area of surface of the paraffined paper, we diminish *pro rata* the capacity of the condenser; but even when the paraffined paper is merely interposed between the ends of two copper wires it still will be a condenser having a definite capacity. There is no need to use paraffined paper to form a condenser. Two metallic plates may be insulated and placed parallel to each other. If they be connected one to one pole of a battery, the other to the other, a current will exist for a finite time. If they are now disconnected from the battery and connected to each other through a suitable instrument for measuring the time integral of current, a return current exists for a finite time. Consider now a condenser consisting of two parallel plates of very large area placed near to each other. It capacity varies as the area of the plates, and it also varies inversely as the distance between them—laws precisely analogous to those of conductors. It also, as might be expected, depends upon the material interposed between the two plates. Since the capacity of the condenser varies as the area, and inversely as the distance, whatever be the substance between the plates, there is a constant for every substance analogous to the specific conductivity of the material; this constant is called the "specific inductive capacity" of the material.

That the magnetic effects of the transient galvanic currents in insulators are the same as of corresponding currents in conductors is a fundamental law at the basis of Maxwell's theory of electromagnetism; it was, I believe, first definitely propounded by Maxwell, and it is one over which some of the most eminent minds have since contended. You will notice how, if the subject be arranged in the unhistorical, but not unnatural, way I have adopted this evening, this law drops so easily into its place that its assumption would be almost unnoticed. Why should we assume that the magnetic effects of electric currents in insulators and in conductors are different. By far the most natural assumption is that they are the same. Maxwell's electromagnetic theory of light—one of the great generalisations of the century—is directly based upon this law. What is this theory? It is simple enough in its character, broadly stated. Suppose you have an electrical disturbance, a transient galvanic current, in any dielectric, this disturbance—assuming the magnetic effects of currents in dielectrics to be the same as in conductors—will be propagated as a wave in directions perpendicular to the direction of the currents. The velocity of the wave can be calculated from purely electrical experimental knowledge; it is 3×10^{10}, if the dielectric be a vacuum. The velocity of light is 3×10^{10}. We know nothing of what light is; we do know that it is a wave, and that the disturbance is perpendicular to the direction of transmission of the light; but what is the ultimate nature of that disturbance we have no idea from the standpoint of the science of light. Is it not infinitely probable that the waves of light are none other than the electrical waves which we know must exist, and must be propagated with the observed velocity of light? And, mark, this theory demands no ether: it merely identifies the phenomenon of light with known phenomena of electricity and magnetism; it demands no knowledge of the fundamental nature of these phenomena: it demands only a knowledge of their laws. Surely Maxwell's generalisation is similar both in kind and in magnitude with the discovery of universal gravitation. Newton showed that the force which caused any body—an apple, if you like—to fall on our earth was the same as the force which kept the planets in their courses. He gave no theory of how that force was transmitted, nor of what, in its inmost nature, it was. He merely identified the two forces as one. So now Maxwell's theory may be shorn of all reference to an ether; it identifies as one the forces whereby light is transmitted and the forces with which we are familiar in our dynamo machines, and shows that they are measurably the same. It does not pretend to say what electricity and magnetism are, or what, if any, is the medium whereby the disturbances on which both depend are transmitted. Whether the postulate of an all-pervading ether be, or be not, a metaphysical necessity, surely it is well for the practical man and the physicist to leave the question to the metaphysician. My point, however, is that the hypothesis of two electric fluids and the ethereal theory of light have rather delayed than accelerated the acceptance of a great generalisation.

Let us now return to elementary matters. I have just stated that the capacity of two large plates near and parallel to each other varies as their area and inversely as their distance. In what units are we to measure capacity? If we have already chosen a unit of resistance, a unit of capacity must follow from that through the units of potential and current. It would be the capacity of that condenser which, if brought to unit difference of potential, would discharge a galvanic current whose time integral was unit current for unit time. It would be quite natural to define as a unit of resistance the resistance between opposite faces of a cube of a defined substance at a defined temperature, in which case the dimensions of resistance would be the reciprocal of a length. Or, again, we might lay by a piece of wire and carefully preserve it, and say, let that be our unit of resistance. Then resistance would have no dimensions in terms of mass, length, and time—it would be a fundamental unit. In either case we should introduce physical constants into our formulæ for electrostatic and electromagnetic phenomena, depending in the one case on the physical properties of the substance chosen, in the other on its actual dimensions. If the history of electrical discovery had followed the course adopted in this discourse, and it had become necessary to fix upon a unit of capacity at the point we have now reached, it would have been very natural to have taken the capacity per square centimetre of two plates at unit distance, the insulating medium being vacuum. We shall see shortly what is the actual electrostatic unit which has been chosen, but the fact is there is nothing specially natural, nothing specially absolute in the choice.

It is a matter of very great interest to know the capacities of condensers of various forms. Let us take, for example, the case of a sphere enclosed concentrically within another sphere. If r_1, r_2 be the radii of the two spheres, the result is that the capacity varies as $\frac{r_1 r_2}{r_2 - r_1}$; if r_2 be very great in comparison with r_1, the capacity varies as r_1. The electrostatic unit of capacity ordinarily adopted as absolute is the capacity of a sphere of unit radius enclosed concentrically in a very great sphere, with vacuum as insulator. From this, remembering that the product of a difference of potential and a galvanic current shall be power in ordinary mechanical units, all other units will follow. Thus time integral of current divided by difference of potential or capacity is a line; therefore, conductivity is a velocity, and resistance the reciprocal of a velocity. Difference of potential multiplied by current is power, and has dimensions $M L^2/T^3$, but potential divided by current has dimensions T/L; there current squared has dimensions $M L^3/T^4$, and current $M^{\frac{1}{2}} L^{\frac{3}{2}}/T^2$, and so on. Again, the capacity of two plates, area A, distance x, can be deduced from that of two concentric spheres at a small distance apart: it is $A/4\pi x$ in these units.

We may now prove that mechanical forces must exist between the plates of a charged condenser. Let a condenser be formed of two parallel plates of area A at a distance x from each other, the distance x being capable of variation; let the condenser be charged to a given difference of potential, and then insulated, and the position of the plates in relation to each other varied. If the condenser be then discharged, it is found, first of all, that the total discharge is the same however the position of the plates be varied. Suppose, now, that the condenser be charged to a difference of potential, E, and a quantity, or time integral, of current, Q, the work done in so charging the condenser will be $\frac{1}{2}$ E Q. Let now the condenser be insulated, and the distance of the plates increased to $x + \delta x$: the capacity of the condenser will be diminished in the ratio $x/(x+\delta x)$; and therefore, since the quantity remains the same, the difference of potential will have increased to $E(x+\delta x)/x$. Now discharge the condenser. The work done by the discharge will be $\frac{1}{2}$ E Q $(x+\delta x)/x$, or an amount of work $\frac{1}{2}$ E Q $\delta x/x$ greater than was done in charging the condenser. This work must come from somewhere. The only way in which it can be introduced is by the work done in separating the plates from each other. To increase the distance

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between the two plates by an amount δx therefore requires that we shall do mechanical work $\frac{1}{2} E Q \delta x/x$ upon the plates. This mechanical work is done through a distance δx, therefore a force must be exerted in separating equal to $\frac{1}{2} E Q/x$; hence it follows, as a matter of necessary consequence from the laws of the capacity of conducting surfaces in the presence of each other, that those surfaces shall, when charged, act mechanically upon each other; and the amount of mechanical force is determined. Now $E . \frac{A}{4\pi x}$ is equal to Q, hence the force between the plates is $2\pi \frac{Q^2}{A}$. Let us now suppose that matter is laid upon each plate of density $\frac{Q}{A}$, and that the matter on one plate attracts that on the other plate with a force varying as the inverse square of the distance: the resultant attractive force between the plates is exactly $\frac{2\pi Q^2}{A}$; hence we should accurately express the facts of attraction of two plates if we said there is on each plate a charge of electric substance, and every particle of substance on the one plate attracts every particle on the other with a force varying inversely as the square of the distance. But that the facts can be so expressed is no evidence that any such electric substance exists.

I do not propose to touch on electromagnetic and magnetic phenomena. I would only point out this: just as electrostatics has been based on action at a distance between hypothetical electric fluids, so magnetism has been based on the action at a distance of hypothetical magnetic fluids. There can be no doubt that the science could be easily rearranged, and that the phenomena of electromagnetism could be made fundamental, and that the facts concerning permanent magnets could be made subsidiary thereto, exactly as we have deduced this evening the facts of electric attraction from the phenomena of current electricity. I believe that in the future this is the way the science must be arranged for practical men. They are but little concerned with the attractions between charged spheres and the like, and very much concerned with the laws of currents and differences of potential and capacities. The theory of permanent magnets has for the modern electrical engineer only a general interest, but the laws of magnetic circuits and induction therein are all-important. It would seem that the subject needs rearranging, and that that which is most important should be put most prominently forwaed. I even venture to think that this would be no loss to pure science; we should see with increased clearness how little we know what electrical phenomena really are, and how much we know of how electrical laws work. We should see how much there is that is arbitary and conventional, and by no means absolute, in the system of units we have adopted. The science of electricity is so essential to the practical electrical engineer that it should be arranged so that he can learn in logical order what he most wants to know. In what I have briefly indicated there will be something which is trite to all, and something perhaps not easy to comprehend when stated too shortly. My aim has been rather to excite in your minds discontent with the way in which the science of electricity is usually arranged in the hope that such discontent may take an articulate form, and become a demand for something more convenient for your particular purpose. When the demand becomes clear, it will not be long before it is supplied.

I am informed by Prof. S. P. Thompson that he has for some time past in his lectures begun the subject of electricity with the consideration of currents. My attention has also been called to Prof. Ayrton's excellent book on practical electricity, with the contents of which I ought to have been, but was not, acquainted, in which a similar arrangement of the subject was adopted no less than nine years ago. J. H.

January 22, 1896.

Prof. Silvanus Thompson, in moving a vote of thanks to the President, said that the address would mark an epoch and give a great stimulus to the advance of the science. He himself was one of those who had long thought that in electrical science they had allowed themselves to be too much bound by the methods and ideas of those who had preceded them. If they could manage to dispose of the antiquated law of last century and realise they worked under the law of the present century, not only would electricians be the gainers, but it would be a gain to science also. The views that had been expressed by the President that evening might be new to many present, but they were not new to all of them; and he (Prof. Thompson) could even have wished that the President might have seen his way to base the fundamental laws of electricity upon the dynamo, and not on the now antiquated galvanic cell In conclusion, he would remark that it was a source of great satisfaction to him to see that their President was among those who deemed it an honour to teach.

Prof. Kennedy, in seconding the vote, remarked that there were many members of the Institution who had passed a certain age, and who had necessarily learned the electricity of the last century. When these came to learn the new electricity, they found that there was a great gulf between the two. If the President had brought it about that that gulf should be more easily passed, or should no longer exist, he would have given great help to the electrical engineer and to the present Institution.

The vote was duly acknowledged by the **President,** who briefly referred to the short time which had elapsed since he had known that the honour and duties of president were to be placed in his hands and which must be his excuse for any shortcomings they might find in his address.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

PRESIDENTIAL ADDRESS BY W. P. JAMES FAWCUS.

I must sincerely thank you for the honour you have done me by electing me your president. To follow in the footsteps of my predecessor, Mr. Edmunds, is no easy matter, but my connection with this society from its commencement has been so intimate and my friendship with a large portion of the members is such that my task will be easier than it might otherwise have been. The Northern Society of Electrical Engineers is eminently a practical society, the whole of its members being actively engaged in their profession. You will therefore, no doubt, prefer me to confine my remarks to practical subjects.

In the first place, I must congratulate the society upon the extremely satisfactory progress it has made. The society was formed two years ago for the purpose of hearing and discussing papers on electrical engineering subjects, and also to give the members an opportunity of meeting together more frequently to discuss commercial questions. Both these objects have been attained, and the society has been supported in a manner which more than realises the expectations of the founders, all the leading electrical engineers in the district and many from a distance, some even from London, having joined our ranks and taken part in the proceedings. On January 22, 1894, the inaugural dinner was held. At that time we had already 107 members on the books; at the present moment we have 145 members and nine associates. Since the commencement of the society we have had read before us a number of papers, many of which have received very favourable mention on account of their practical character. We have also promised to us for this session a number of what I believe will prove to be most interesting communications. The society has served to bring together, to their great mutual advantage, many who might not otherwise have had an opportunity of meeting. It has, I believe, promoted a more healthy and friendly tone throughout the trade, and by constantly bringing together some who formerly looked upon each other only in the light of rivals has promoted friendships, and in many cases established commercial relationships and led to business being reciprocated between members of the society which would otherwise have gone elsewhere. I myself have experienced in no small degree the help and assistance of gentlemen whom but for the society I should not have known, at all events intimately.

There remains, however, in this direction much to be done. We still have working amongst us—though, I hope, not members of our society—many whose methods of obtaining business are by no means honourable or fair. Those who make false or misleading statements about the work of their competitors with a view to injuring them in their calling; those who by undertaking work at low prices, often using inferior materials and workmanship, cripple the business of others who are attempting to do good work at a fair price; those who with an insufficient knowledge of the work they are undertaking make mistakes costly to their clients and often disastrous to themselves—these it is who destroy the confidence of the public in the honesty of the trade and do much to retard the industry. It should be the duty of the members of this society to use collectively and individually all means within their power to discourage such conduct. During the past year, although there have been no remarkable new developments in our science, much solid progress has been made. To my mind electricity has hitherto been too much associated with sealing-wax and string, but I think we can congratulate ourselves that we now give as much attention to mechanical soundness as to electrical efficiency.

In electric traction it is satisfactory to see the large number of schemes which are in the process of development or in course of construction; there is little doubt that in the course of a few years the majority of the tramways in this country will be worked by electricity. The vast superiority of electric power for this purpose over either horse, steam, or cable traction has been amply proved at all events to the minds of all thoughtful electrical engineers, although no doubt much remains to be done in convincing many of our municipal authorities. The stumbling-blocks, so far, in the way of development in this direction have been the supposed unsightliness of overhead wires, and the imaginary difficulties in the use of conduit systems. In the former case the objections have arisen from the temporary character of the work of that kind in the States,

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but the excellently-arranged systems recently inaugurated at Bristol and Coventry have already gone far to remove these prejudices, and in the latter case the successful working of the new systems in operation in the United States and on the Continent, and the inventive efforts at present being devoted to the subject, will no doubt shortly remove this difficulty also. It is very satisfactory to note that at Leeds both overhead and conduit systems are to be installed. The use of electrical transmission of power, especially in large works, is increasing rapidly, and I have no doubt a large amount of work, and, I hope, profit, will come to the industry from this source. Several demonstrations on a large scale have recently taken place of the saving to be obtained from this method of transmission, and the fact that these experiments have been satisfactory is proved by the number of enquiries now coming in from all sources to the leading firms in this country for power plants. In those branches we have, unfortunately, so far been much behind our Continental and American competitors, but the engineers of this country are now thoroughly in earnest, and it will be strange if we cannot recover our lost ground and outstrip our rivals, as we have done in every other department of engineering industry. Perhaps the most satisfactory progress made during the last 11 months is in electricity supply works; not only have a large number of new undertakings commenced their operations, in most cases with great promise of success, but established undertakings have enormously increased their load. It is also extremely satisfactory to notice the increase in the popularity of electricity as a heating and cooking agent. These uses will ultimately greatly help the day load, especially if wisely encouraged by means of favourable terms being granted for current used for purposes other than lighting.

We have recently had read before us a paper by one of our members (Mr. Manville), in which he described the scheme which the Corporation of Swansea has in contemplation for utilising their generating plant for working the tramways, and so providing a magnificent day load. It is expected that it will be possible to sell electricity for this purpose at 2d. per unit. Should this expectation be realised, the impetus given both to electric traction and electric lighting will be very great, and the combination of lighting and traction schemes will become general. New rules were recently drawn out by the Board of Trade for the regulation of electric supply undertakings, but as these rules would, in the opinion of most central-station engineers, have injuriously affected the industry, a large number of protests were lodged against their being put into operation without revision, with the result that the Board of Trade consented to hear the views of the objectors at a meeting held in London in November last. At this meeting, which consisted of the representatives of most of the corporations and companies owning electricity supply works, this society and the Institution of Electrical Engineers were represented; and I am glad to be able to report that the objections to the rules were met by the Board of Trade in a most reasonable manner, with the result that the new rules, when issued, while duly safeguarding the interests of the public, will not unnecessarily harass the undertakers.

A step of great importance to engineers, especially those having charge of continuous-current stations, is the introduction of high-voltage lamps. At the present time lamps are in use in several stations working at pressures of from 200 to 230 volts, and have proved themselves satisfactory when properly made. Those which have so far proved the best have two or more filaments arranged in series, no filament having to stand an abnormal pressure; made in this manner, it is possible to obtain a good lamp for 230 volts as small as 8 c.p., while a lamp of 16 c.p. can be made to run with pressures up to 400 volts. The possibility of obtaining lamps for such high voltages will no doubt induce engineers to gradually raise voltages within the premises of consumers, and here I should like to strike a note of warning. Although there may be no objection to using pressures up to 400 volts in public buildings or elsewhere when the installation is under experienced control and the fittings are inaccessible to the public, for private houses and ordinary business premises, where the inexperienced cannot be prevented from having access to the wires and fittings, 200 to 259 volts are quite high enough for personal safety. Even if there is no actual danger to life from the direct effects of a shock of from 250 to 400 volts—a question which is open to doubt—the indirect results of such a shock might be most injurious, or even fatal, if received by a delicate person or one in a dangerous position. It would be an evil day for the industry if through the occurrence of fatal accidents to the general public the electric light should again get the name of being dangerous, which, fortunately, it has now practically lived down. There is another reason why considerable caution should be exercised in converting existing installations from low to high pressures: the types of switches and other fittings commonly in use are totally unsuited to pressures much beyond what they were designed for, and in the case of some of the older installations, the insulation on the wires will be insufficient.

Attention has recently been drawn to the subject of life and efficiency of incandescent lamps by the tables and correspondence which have recently appeared in the technical papers on lamp tests. It is surprising how few of the public, or even of practical electrical engineers, take the trouble to learn anything about incandescent lamps, when by using a little knowledge on this subject it may often be possible to reduce the cost of lighting to one-half. It is possible for a lamp manufacturer to produce lamps to suit a variety of different conditions, provided he is made aware of them, but as he seldom is furnished with any particulars beyond the candle-power and volts at which the lamps will have to work. He frequently has his lamps condemned as bad, when in reality there is nothing the matter with them if used under proper conditions. In certain cases it may be desirable for the consumer to use a lamp which, although working at a comparatively low efficiency, will keep its full candle-power during its life; lamps of this type can easily be procured. In other cases it may be preferable on account of the cost of energy to use a lamp which will consume a minimum of current. In this case the consumer must be prepared to sacrifice either constancy of candle-power or duration of life. No lamp has so far been produced which combines a long life with high efficiency and constant candle-power. Again, it may be impossible to guarantee the regularity of the pressure at which the installation runs. Under these conditions an ordinary lamp would have a short life, but if the maker is made aware of them he can specially construct one suitable.

I have for the last few weeks been engaged on a series of experiments upon lamps of most of the leading English and Continental makers. During these experiments one or two interesting points, which may not be known to all of you, have come under my notice. I have observed in the case of many lamps commencing their life with an efficiency of about four watts per candle-power (a very usual efficiency), that in the course of from 100 to 150 hours' run the candle-power has increased as much as 20 to 30 per cent., and the watts from 15 to 25 per cent., and has then gradually fallen until the end of their life. Installers should bear this point in mind, as the use of such a lamp in an installation where the plant had not a fair margin of power might well lead to trouble through overloading. I have also observed that in some lamps commencing their life with an efficiency of from 2½ to 3 watts per candle-power, no rise, or, at all events, a very slight one, was observable in the candle-power at any period of their life, but a steady and fairly rapid fall from the commencement until a critical period is reached at between 300 and 500 hours when the lamps reach almost their minimum efficiency from 4 to 4½ watts per candle-power, and continue in this state for the remainder of their life, which in the case of some of the better lamps has averaged considerably over 1,000 hours. This would point to the advisability of using a high-efficiency lamp as such for a time, and subsequently moving it to a less important position for the remainder of its life, being content with about half its original light—it would then be no worse than an ordinary lamp of the lower candle-power. I hope in the near future it may be possible for supply undertakings to sell light to their customers, and not current. For only in this way will it be to the advantage of the engineer (generally the only person competent to come to a just conclusion) to see that the current is being consumed by suitable and efficient apparatus.

It is somewhat an unsatisfactory sign that so much foreign material is being sold in this country, and is in many cases introduced and encouraged even by those who are striving in other branches of the industry to compete against it. British electrical engineers are now entering on a critical period of their existence; they are being threatened on all hands by foreign competition, and unless they wish their business to get into the hands of the German they must not only strive to keep up the high reputation which English workmanship has always possessed, but must be prepared to support one another by reciprocating business and refusing to buy abroad when it is possible to obtain as good an article at home.

ALTERNATE-CURRENT TRANSFORMERS.

BY DR. J. A. FLEMING, F.R.S.

On Monday evening last Dr. Fleming gave the first of a course of four Cantor lectures on the above subject at the Society of Arts, John-street, Adelphi.

After alluding to a course of lectures delivered on the same subject three years ago, Dr. Fleming said that on this occasion he proposed to omit the elementary parts of the subject and address himself as a specialist to specialists. There were three kinds of transformers which might be discussed: the mathematical transformer, a beautiful and much-admired instrument; the contractor's transformer, the characteristic of which was its extremely high efficiency; and, lastly, the practical transformer in real use. This, with all its faults and phases, was the one he proposed to consider, in disregard alike of academical theory and faulty practice. The proper form of transformer was, it would be seen, a matter of considerable

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practical importance when it was remembered that there were 47 alternating stations in the kingdom. The energy absorbed in hysteresis would be 40,000 kilowatts, if not more, from which it worked out that something like 8,000 tons of coal a year were employed in the magnetising many times a second an aggregate weight of cores amounting to 400 tons of laminated iron. A transformer might be regarded as an instrument by which an increase or decrease of current strength was purchased at the expense of a change of potential. It consisted of three organs: the primary circuit, the secondary circuit, and the magnetic circuit. The primary circuit was interlinked with the magnetic circuit, and this again was interlinked with the secondary circuit. By varying the relative number of linkages, electrical power in the form of a small current was changed into electrical power in a large current, with, however, some loss of power in the process. This was doing precisely the same thing as was done with mechanical power by a "simple machine," and they had in that case an exact analogy of the loss of electrical power in the loss by friction. After briefly alluding to the possibility of classifying transformers according to whether they had or had not iron cores, whether or not the magnetic circuit was complete, or, again, as step-up and step-down transformers, the lecturer said that just as the indicator invented by Watt showed what went on inside an engine cylinder, and was necessary for the theory of the steam-engine, so the theory of the transformer was imperfect and academic until a method was invented of delineating what was going on at each instant inside it. To do this it was necessary to have a means of ascertaining the instantaneous value of the potential at any moment between its two maximum values. If a condenser was connected to an alternator its potential would follow the same law as that of the alternator, and if it were suddenly disconnected it would remain at the momentary potential, which could then be measured. What was necessary was an arrangement making contact always at a given instant of the phase. The lecturer then described the apparatus used, the momentary contacts being secured by a small alternating-current motor running in step with the alternator. If observations were taken of the potential at short intervals from maximum to maximum, curves could be plotted of the E.M.F. either in rectangular or polar co-ordinates. The latter were of use as giving more easily the ratio between the maximum potential and the square root of the mean squares value, which was what is measured by a voltmeter. The name given to this ratio was the "form factor." A quantity of curves had been taken by Messrs. Morris and Pettivell in this way at the Bankside works, and the remainder of the lecture consisted of an exhibition of a large number of them, showing how their forms were affected by varying the load and the induction. For instance, it was shown that the Mordey alternator gave a smooth rounded E.M.F. curve both at no load and with a non-inductive resistance. If a Mordey alternator was coupled with a Thomson-Houston, the form remained essentially similar. But the Thomson-Houston alone gave a much sharper curve with higher maxima, so that the Mordey alternator impressed its own form of curve on the combination. In the Mordey alternator there was very little armature reaction, and the current curve corresponded closely to the E.M.F. curve, but in the Thomson-Houston it was much affected by altering the load and the shape of the curve being altered. Another point brought out was that the form factor must not be assumed in any case, since it depended on the load. The two curves might have the same mean value, but their maxima would be very different—a matter that must be carefully considered in testing cables. After further illustrations of the effect of induction and current lag on the form of the curves, the lecturer passed to the analysis of the curves by the mechanical harmonograph. It was found that nearly all the curves that were met with in practice could be analysed into simple sine curves whose frequencies were in the ratio of 1 : 3 : 5. Such a curve could consequently be completely represented by a chord composed of G (bass clef), D (between the staves), and B (treble), the vibration periods of which were 96, 288, 480 per second, and the intensity with which the notes were struck corresponding to the altitudes of the curves. Passing to curves taken from transformers, the lecturer pointed out that the curve of the transformer followed exactly the form of the primary curve. It had been said that the transformer wiped out irregularities. That was not the case. An experimental proof of this might be found in the telephone. The transmitter had in it an induction coil, yet the sounds were exactly reproduced, and therefore the wave form must be unaltered. After explaining the theoretical relation between the E.M.F. curve and the curve of magnetic induction in the core, it was remarked that in practice the magnetic circuits were not wholly interlinked with the primary and secondary circuits, so that the results obtained by integrating the induction of the primary and secondary circuits were not the same. Curves of hysteresis were next exhibited, though this subject was in the main left over to the next lecture on January 27, which will deal with hysteresis losses and the construction of the transformer.

LEGAL INTELLIGENCE.

THE EDISON AND SWAN TRADE-MARK.

At the Central Criminal Court on Monday, before the Common Serjeant, Edward Augustus Ingold (30), engineer, and Alfred Attride (34), a horse trainer, were indicted for falsely applying to certain lampholders a mark resembling the trade-mark of Messrs. Edison and Swan in such a manner as to be calculated to deceive. Mr. C. Mathews and Mr. C. F. Gill prosecuted, and Mr. Schullers Young defended Ingold, and Mr. Hutton and Mr. Collison, Attride.

Ingold at one time was in the employ of the prosecutors, and after leaving he became the London agent of a German firm, from whom he ordered in different names large quantities of electric light holders. The addresses given of the firms in whose names the holders were ordered were newsagents' shops or the private houses of the relatives and friends of Ingold. Having got possession of the holders, it was alleged that the two accused men proceeded to get them stamped. For a time, no doubt, they were stamped with a genuine stamp of a firm of licensees of the patentees, but the stamp was, unknown to the licensees, taken away from their premises by a workman who was afterwards dismissed. Attride, in the name of Ford, then induced a man in Clerkenwell to make a stamp and to stamp the articles. In disposing of them, the prisoner Ingold represented that he was acquainted with a bailiff who had taken the lampholders for a debt, and, with regard to the others, he said a dealer had bought a job lot for him. They were purchased in the belief that they were the genuine Edison and Swan holders.

In defence, it was urged that Attride, who was a rough rider engaged at the Aquarium, was an innocent agent in the matter and on behalf of Ingold it was contended that he had used the words "Edison and Swan patent," and that this was not a colourable imitation of the registered trade-marks "Ediswan" and "Edison-Swan" Complaint was also made that the firm had made this a criminal instead of a civil matter.

The jury convicted Ingold, but acquitted Attride.

George Cosgrave, 22, an engineer, pleaded guilty to a similar offence in falsely applying the trade-mark to the holders, and on the application of the prosecution was bound over in the sum of £100 to come up for sentence if called upon.

Mr. Mathews said Ingold had been the prime mover in this matter, and had confessed to having sold 13,000 of the holders. He had a further 3,000 on order, and on him were found orders for 4,000 and 5,000 more. It was he who had tempted the other men.

The **Common Serjeant** sentenced him to nine months' imprisonment without hard labour.

COMPANIES' MEETINGS AND REPORTS.

DIRECT UNITED STATES CABLE COMPANY, LIMITED.

The ordinary general meeting of the Direct United States Cable Company, Limited, was held on Tuesday at Winchester House, Sir John Pender, M.P., presiding.

The **Chairman**, in moving the adoption of the report, stated that the revenue for the six months ended the 31st ult., forming the first half of the Company's current financial year, amounted, after deducting out-payments, to £43,938. The working and other expenses, including income tax, but excluding the cost of cable repairs, absorbed £19,058, leaving £24,880 as the net profit for the half year, making, with the amount brought forward, a total of £26,290, out of which two interim dividends of 2s. each per share had been declared, and £10,000 had been transferred to the reserve fund, leaving £4,148 to be carried forward. The revenue, which had commenced to improve in the early part of last year, had still further progressed within the last six months, for which period it showed an increase of £5,596, or more than 14 per cent. as compared with that of the corresponding period of 1894. Nevertheless, their aggregate ordinary expenditure had been only £34 greater. The cost of repairs to cables had been heavier than usual, having amounted to £6,984, which had been charged against the reserve fund account as usual. On the other hand, the fund had been credited with £4,619 for interest on the investments, and with £10,000 from the revenue account, bringing the balance of the reserve fund up to £306,000. The investments had been increased during the half-year by £16,400, and their present market value was about £55 000 more than they cost the Company. They had considered it very advisable to keep up a good reserve fund. They were getting to the end of the twenty-fifth year of their existence as a cable company, and as they had put in a great many repairs during the last 12 months and the last two or three years, they would still find if they were thrown on their beam ends that they would be short of the amount required to give them a new cable; and therefore they had always to look ahead and take care that they were not caught sleeping. The six months they had just passed through had been rather exciting. They had had politics, and they had had a good many things going on in America which had caused some anxiety. But he still thought that common sense would prevail, and that a settlement of the question which was now being agitated in America would thus be arranged. He had received four letters from different shareholders who complained of the rate of dividend and desired to see it increased. He should be only too glad to recommend the payment of a higher dividend, and if things went on as well as at present he hoped they would be able to do so next time.

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He found it was far more easy to declare a dividend than it was to get one back, and they had to look well ahead and keep everything in proper working order, but he thought he could promise something in six months' time more than they were giving now. During the past year it had cost £7,000 to repair the cables; one cable had been hanging on a rock in the Irish Sea for 22 years, and had at last been cut through, but they were now all in working order. They were working the duplex upon their system now, and they had not been working it for four or five years. Although they carried a large sum over to the reserve fund, they drew out of that reserve the amount required to effect the repairs.

Mr. E. M. Underdown, Q.C., seconded the motion.

A brief discussion followed, and, in answer to questions, the **Chairman** stated that they had adopted Muirhead and Taylor's recorder, and he was quite satisfied, having consulted Lord Kelvin and their own scientific men on the matter, that the Company possessed a very valuable recorder. When the duplex was working they did not require the same amount of speed as when it was not in operation, but when the duplex was not working the automatic transmitter gave them about 40 per cent. of additional speed, which was very important. Everything was uncertain with America at the present time, and if the Company had to cease working their revenue would be affected. It was better not to begin to pay a higher dividend until the way was clear. Their traffic at the present time was 17 per cent. in excess of that at the same period last year. Cables had lately been established which affected them, the additional lines being in excess of the requirements of the Atlantic traffic. The advice which had been given to them to sell their Consols was not, he thought, bad advice. He believed they had cost the company about 96, so that their realisation would give them a good profit. As to the injury which might be done to submarine cables in the event of war, he once endeavoured to get the Government to make an agreement by which the lines would be protected, but the reply he received was that the Government would agree to it at once, only the general who would be in command would break it. That was what they all feared. He, however, did not believe that cables would be deliberately broken if it could be helped, although they might be interrupted.

Mr. John Newton said he believed that the destruction on railways in time of war would be far more disastrous than any damage which could be done to cables. Cables could be stopped working by one effective cut, which could be easily repaired afterwards. He had never had the slightest apprehension that war would interfere with cable property beyond stopping the revenue for the time being of any particular cable.

The **Chairman** said that he was very much disposed to take the same view.

The motion was carried unanimously, and a vote of thanks to the chairman concluded the proceedings.

EASTERN TELEGRAPH COMPANY.

The half-yearly ordinary general meeting was held at Winchester House yesterday, Sir John Pender, G.C.M.G., M.P., presiding. The report of the directors stated that the revenue for the six months ended September 30, 1895, amounted to £409,779. 15s. 6d., from which are deducted £96,703. 19s. 7d. for the ordinary expenses, and £47,165. 2s. 7d. for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing £3,423 4s. 7d. for depreciation of spare cable, £821. 2s. 3d. due to revaluation of currency assets, and £5,748. 15s. 5d. for income tax, there remains a balance of £255,917. 11s. 1d., to which is added £1 252. 3s. 9d. brought from the preceding half-year, making a total available balance of £257 169. 14s. 10d. From this balance there have been paid: interest on debentures and debenture stock, £27,520. 11s 8d.; dividend on preference shares, £20,296. 5s 5d.; two interim dividends of 2s. 6d. per share each on the ordinary shares, £100,000; making a total of £147,816 17s. 1d. After carrying £10,000 to the reserve fund for maintenance of ships and £50,000 to the general reserve fund, there remains a balance of £49,352. 17s. 9d. which is carried forward to the next account. The revenue includes £25,447. 14s. 2d., dividends for the half-year upon the Company's shares in the Eastern and South African, the Black Sea, the Direct Spanish, and the African Direct Telegraph Companies.

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq., Elibank, Taplow; Sampson Hanbury, Esq., Wyvenhoe Park, near Colchester; S. Barclay Heward, Esq., 96, Ashley-gardens, Westminster; Edwin Tate, Esq., 21, Mincing-lane, London, E.C.

Report of the directors, with abstract of accounts for the half-year ending December 31, 1895, to be submitted to the half-yearly ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on Tuesday, Jan. 28, 1896, at 12 noon:

The receipts from all sources for the past half-year have amounted to £24,554. 9s. 2d., and the cost of working has been £14,638. 16s. 4d., leaving a profit of £9,915. 12s. 10d. Inclusive of the balance brought forward from December 31 last, the net revenue account shows an aggregate total of £10,922. 7s. 4d. After making provision for the debenture and debenture stock interest, a balance remains available for dividend of £7,111 7s. 1d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 1¼ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,219. 16s. 1d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Receipts (including season tickets).
Dec. 31, 1890 (11 days)	165,000	£1,568 3 9
June 30, 1891	2,412,343	19,403 6 9
Dec. 31, 1891	2,749,055	19,798 16 6
June 30, 1892	2,813,162	20,931 4 2
Dec. 31, 1892	3,117,602	22,002 17 5
June 30, 1893	3,146,656	22,458 6 9
Dec. 31, 1893	3,093,351	22,067 14 10
June 30, 1894	3,383,154	23,564 10 6
Dec. 31, 1894	3,275,649	23,540 12 4
June 30, 1895	3,113,199	23,711 5 8
Dec. 31, 1895	3,172,438	23,780 3 7
Total since the opening of the line	30,441,609	£222,827 2 3

During the summer quarter of the past half-year the traffic of the line was considerably diminished by the unusual and prolonged heat which then prevailed, and since that time the traffic of the line has suffered from the entire closing of the Oval for football matches, but notwithstanding these drawbacks there is an increase in the receipts, and this is especially noticeable in the item of season tickets, which indicates the steadily-growing confidence of the public in the convenience, safety, and punctuality of the line. In regard to the extension of the line to Finsbury-pavement, your directors have the pleasure to state that most satisfactory arrangements have now been entered into in respect to the more important properties required, and are such as justify them in fully believing that the proposed extension can be carried out within the estimate named in their report of January 22 last, approved by the shareholders at the half-yearly meeting on February 1 following. Preparations are therefore being made for carrying out the extension without delay, and the proprietors will be asked at the extraordinary general meeting called for that purpose, out of the capital of the Act, 1893, to be then created, to sanction the issue of 20,000 5 per cent. preference shares of £10 each, which it is estimated will be sufficient to provide the amount required. It is intended that in the issue of these shares, arrangements shall be made that no charge will fall upon revenue in respect to the dividend upon them, until after the time at which it is estimated the extension will be open for traffic, and earning a larger sum than will be required for that purpose. The alterations at King William-street Station, to which reference was made at the last meeting, have occupied a longer time than was expected owing to the necessity of avoiding interference with the existing traffic, but they are now completed, and will be brought into use in the course of a few days. The difficulty of dealing with the morning and evening traffic still continues, involving a considerable loss of revenue, but it is hoped that the additional trains which these alterations will accommodate will enable the press of traffic at those times to be better provided for. The additional sidings at Stockwell referred to in the last report are now finished, and will add greatly to the convenience of the working of that station. In view of the increased number of trains to be run, seven additional carriages have been ordered, and an additional locomotive built in the Company's own shops is nearly completed. The generating plant, which is in good working order and repair, has been materially strengthened by the erection of a small engine and dynamo, which will effect a decided economy in working the traffic in the less busy part of the day. An order has also been given for the erection of a condensing apparatus at the generating station, which it is anticipated will make a considerable reduction in the quantity of coal consumed. During the past six months a further sum of £9,400 terminable mortgage debenture bonds has been paid off. As the powers of the Company for the compulsory purchase of lands in connection with the Act of 1893 will expire in August next, application is being made to Parliament for a further extension of that time. In the same Bill powers are sought for the acquisition of a site for a temporary shaft in the High-street, Borough, with the view of saving expense in the construction of the junction of the new extension with the existing tunnels. This Bill will be submitted to you at the special general meeting of which notice has been given. The engineer of the Company, Mr. Basil Mott, having resigned his position in order to take up an appointment in connection with the construction of the Central London Railway, Mr. P. V. McMahon, who has acted for some years as assistant engineer, has been appointed to succeed him. The directors retiring by rotation are Messrs. Charles Seymour Grenfell and Edwin Tate, who are eligible and offer themselves for re-election. Mr. James Loriner Oliver is the auditor to retire on this occasion and is eligible for re-election.

Dr. REVENUE ACCOUNT.	£ s. d.
Maintenance of way, works, and stations	462 4 10
Locomotive and generating power	5,707 8 2
Carriage repairs	453 17 5
Traffic expenses	5,663 10 6
General expenses	1,631 1 8
Law charges	7 12 6
Rates and taxes	660 15 10
Passenger duty	52 5 5
	£14,638 16 4
Balance carried to net revenue account	9,915 12 10
	£24,554 9 2

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Cr.	£	s.	d.
By passengers (3,172,438)	22,650	13	6
Season tickets (573)	1,129	10	1
	23,780	3	7
Parcels, etc.	78	1	3
	23 858	4	10
Transfer fees	15	12	6
Rent of property	654	14	4
Sundry receipts	25	17	6
	£24,554	9	2

Dr. GENERAL BALANCE-SHEET	£	s	d.
Balance from net revenue account	7,111	7	1
Unclaimed interest	142	19	11
Interest payable or accruing and provided for	1 227	16	2
Sundry outstanding accounts	6 599	17	0
	£15,082	0	2

Cr.	£	s.	d.
Cash at bankers—current accounts	3,094	14	3
,, in hand	640	1	2
	3 734	15	5
General stores	3 562	15	10
Sundry outstanding accounts	543	7	10
Balance from capital account	7,241	1	1
	£15 082	0	2

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Parma (Italy).—The municipal authorities of the city of Parma desire tenders by February 25 for the electric lighting of the city from June, 1897, to 1912.

Cattowitz.—Tenders are invited by January 29 for the supply of carbons for arc lamps at the railway. Particulars from the Königl Eisenbahn-Direktion (Room 7 of the Administration Building), Cattowitz, for 50pfg (6d.).

Soria (Spain).—Offers are wanted for the concession of the electric lighting of Soria for 20 years on the basis of an annual payment of 9 000 pesetas. Particulars from the Municipal Offices Soria, where tenders must be sent by January 30.

Teneriffe (Canary Islands).—Tenders are invited for the electric lighting of the town of Santa Cruz, Teneriffe, for a period of 35 years. Particulars can be obtained at the Ministerio de la Gobernacion, Madrid, and tenders must be delivered by February 29.

Aussig.—The communal authorities propose to have built a seven-mile single line tramway. The choice of system is left open Contractors are invited to place themselves in communication with the Stadtrath, Aussig-a.-d.-Elbe, Prussia. Tenders are to be in by January 31.

Swadlincote.—The Swadlincote Urban District Council intending to light the township of Stanton with electric lighting, invite tenders for the work. All particulars can be obtained from Mr. R. Cartwright, surveyor, Swadlincote, to whom tenders must be sent by 27th inst.

Paris.—Tenders are asked for the supply of 500,000 kilogrammes of galvanised wire and various telegraphic supplies for the State telegraphs. Application for permission to tender must be made by February 3 to La Direction Générale des Postes et Télégraphes, Rue de Grenelle 3, where particulars may be obtained.

Ramsgate.—Tenders are invited for electric lighting at the Promenade Pier, Palace of Varieties, and Marina Restaurant, for the Ramsgate Marina, Pier, and Lift Company, Limited. No specification has been prepared, but particulars of what is required can be had on application to the Secretary, 23, Martin's-lane, Cannon-street, E C.

Lindley (Huddersfield).—Tenders are invited for the electric lighting engineer's work required at Zion Methodist New Connexion Chapel, Lindley, Huddersfield. Drawings and specifications are at the offices of Messrs. John Kirk and Sons, architects, Huddersfield and Dewsbury. Sealed tenders are to be sent to the architects by 3 p.m. on the 29th inst.

Huddersfield.—The Electric Lighting Committee of the Corporation invite tenders for the supply of two steam-boilers, four mechanical stokers and one surface condenser, with air and circulating pumps. Specifications and forms of tender may be obtained of Mr. A B Mountain, borough electrical engineer, St. Andrew's-road, Huddersfield. Tenders, endorsed "Tender for Electrical Machinery," must be delivered to the town clerk, Town Hall, Huddersfield, by February 4.

RESULTS OF TENDERS.

London, S.W.—The Guardians of Chelsea have accepted the tender of Messrs. Graham and Biddle, at £338. 12s. 6d., for fitting up an electrical wiring installation with fittings in the infirmary.

Colchester.—The War Office has placed the contract for the internal wiring and fittings for the electric lighting of the new military hospital at Colchester with Messrs. Paterson and Cooper, Dalston, N.E.

BUSINESS NOTES.

Kirkcaldy.—The Town Council have appointed a committee to enquire into the question of introducing the electric light.

Castleford.—The Urban District Council are considering the advisability of lighting the streets and market by electricity.

Clontarf.—The Township Commissioners have approved of the electric tramway scheme submitted by the Southern District Tramways Company.

Swansea.—A resolution has been passed by a ratepayers' meeting authorising the promotion by the Corporation of the Bill for the purchase of the tramways

Dover—At a meeting of the Working Men's Institute an almost unanimous vote was given in favour of the Corporation providing tramways worked by electricity.

City and South London Railway.—The returns for the week ended January 19 were £1,004, compared with £996 for the corresponding period of last year, being an increase of £8

Llandrindod.—A special meeting of the Urban District Council has been summoned to consider the question of an agreement with Mr. S Jevons for lighting the street lamps with electricity.

Western and Brazilian Telegraph Company.—For week ending January 17, the receipts, after deducting 17 per cent. payable to the London Platino Brazilian Telegraph Company, were £2,915.

Maidstone.—The proposal to transfer the powers of Electric the Lighting Committee to a company promoted by Mr. Thomas King, has been deferred to the next meeting of the Urban District Council.

Dundee.—The Court of Directors of the Royal Lunatic Asylum think the time is rapidly approaching when they would be required to deliberate as to the introduction of electric light into the buildings.

Wimbledon.—The Urban District Council have decided that application be made to the Board of Trade for an extended license for such period as will enable the Council to obtain a provisional order for electric lighting.

Hampton.—The District Council have decided to request an electrical engineer to give an opinion as to the probable cost of lighting the district with the electric light if the cables were laid at the same time as the sewers.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending January 19 amounted to £1,172, as compared with £900 in the corresponding week of the previous year being an increase of £272.

Pembroke.—The Town Council have resolved to give the Pembroke Ward power to introduce electric light. Motive power will be supplied by a Pembroke mill-owner, and Mr. J. T. Ford is going to lay down plant at his own risk.

St. James's and Pall Mall Electric Light Company.—The directors recommend a dividend at the rate of 10½ per cent. per annum on the ordinary shares for the half-year ended December 31, making, with the interim dividend, 7½ per cent. for the year 1895.

Presentation.—Sir Joseph West Ridgway, Governor-Designate of Ceylon, has been presented with a handsome gift by the directors of the Manx Electric Tramways Company. The presentation took the form of an album of 60 large photographic views of the island.

Sydney (N.S. Wales).—The report of the Government Railway Department notes with satisfaction the addition of a multipolar generator and four motors to the cars on the military road overhead electric line. These enable the motor cars to haul two trailers.

Nuremberg.—The Elektricitäts Atkien-Gesellschaft vormals Schuckert und Co. is about to follow the example of the Helios Company at Cologne and increase its capital. A large extension of the works and the putting down of a quantity of new plant is contemplated.

Westminster Electric Supply Corporation, Limited.—The directors of this Corporation have decided to recommend that a dividend at the rate of 9 per cent. should be paid for the past half year, making, with the interim dividend already paid, a dividend of 7 per cent. for the year.

Liverpool.—The tramway company have been experimenting with mechanical haulage. After rejecting steam and compressed-air locomotives and the cable system, they finally decided against electric traction on the accumulator system, on the ground that it would prove more expensive than horse haulage.

Eastern and South African Telegraph Company, Limited.—This Company announce the payment by warrants on February 1 next of interest for the half-year ended January 31 on its 4 per cent mortgage debentures. The transfer books will be closed from January 28 to February 1, both days inclusive.

Aberdeen.—The Watching and Lighting Committee of the Town Council have decided to erect two overhead electric lamps in Bridge-street, one at the top and the other about 60 yards down. The Docks and Pilotage Committee of the Harbour Board are considering the advisability of lighting the quays by electricity.

Cork.—There have been no objections lodged against the Bill which the Town Council are promoting in Parliament for lighting the city by electricity, but the town clerk has received a letter from the secretary of the Cork Harbour Commissioners asking that some amendments should be made in one of the clauses of the Bill.

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Eastern Telegraph Company, Limited.—This Company notify that the coupons on its 5 per cent. debentures due February 1 next will be paid, on and after that date, at the banking-house of Messrs. Glyn, Mills, Currie, and Co., 67, Lombard street, E.C. Coupons should be left at the bank three clear days for examination.

New Address—The offices, showrooms, and engineering staff of the Consolidated Telephone Construction and Manufacturing Company, Limited, have been removed from 109, Farringdon-road to 186 and 188, Shaftesbury avenue, W.C., and the works, under the title "Telephone and Electrical Works," are at Coventry.

Bangor.—The Commissioners have agreed that before they decide on the various powers to be sought for in the provisional order they make enquiries in a number of seaside resorts in England, Scotland, and Wales as to the extra powers taken in provisional orders, as they might find something among them which they could also include.

Aberdeen.—The National Telephone Company have brought into requisition at their central office in Market-street a new switchboard, which, while conducing to the comfort of the operators, will also tend to improve the working of the system. The work of fitting up the board has been carried out under the superintendence of Mr. W. Brown, district manager.

A Telephone from London to Berlin.—In the course of the debate upon the Post Office Estimates in the Reichstag, Dr Stephan, Postmaster-General, quoted statistics showing the vast extension which the German postal and telegraphic system had undergone since 1870 and said that it was intended to establish direct telephonic communication between London and Berlin.

Baker-street and Waterloo Railway.—The engineers to the authorised Baker-street and Waterloo Electric Railway have deposited with the Private Bill authorities an estimate of the cost of the proposed extension of the railway to the St. John's Wood terminus of the Sheffield Extension Railway. They estimate that the construction of the further length of line required will be £99,043.

Camberwell, S.E.—The Vestry have decided to offer no objection to the application for a provisional order for electric lighting the district and for the supply of electrical energy by the County of London and Brush Provincial Electric Lighting Company, on condition that separate accounts were kept for Camberwell, and that the Vestry have the power to purchase the undertaking at the end of 21 years.

Taunton.—The Electric Lighting Committee have informed the Council that an application had been made to the Board of Trade for an extension of the time allowed for placing all the mains underground, but they had declined to grant such extension, and said the overhead wire should be removed. The committee had therefore resolved to proceed with the work of laying the cables and removing the wires.

Surbiton.—The District Council have received tenders for lighting the town by electricity from the following: The Capital and Counties Electricity Supply Company, Messrs. Siemens Bros. and Co., the Brush Electric Lighting Company, Messrs. Crompton and Co, Messrs. Sharp and Kent, Messrs Fowler and Co. These tenders will be reported on by Dr. Hopkinson, who has been appointed consulting engineer.

New Company.—The Lancashire and General Tramways and Carriage Company, Limited, was registered on January 17 by J. C. Walker, Dean, and Co, Manchester, with a capital of £10 000 in £5 shares. Object: to obtain rights to run over and work any tram or rail roads in the county of Lancashire. The directors are A. Pilling, H. P. Holt, and E. Bryning. Qualification, £50. Remuneration to be fixed by the Company.

Electricity in Coolgardie.—Mr. Edmund Mitchell, managing director of Scottish Westralia, Limited, who recently went out to Western Australia to arrange with the Government in regard to the introduction of electric power to the fields, has completed the arrangements with the Cabinet whereby they will be enabled to at once proceed with the installation of power works in the colony. The patents of the invention have not yet been completed.

Liverpool Overhead Railway.—The report of this Company for the past half-year ending December 31 states that the accounts show an available balance of £11,499. The directors have resolved to recommend the payment of a dividend of 5 per cent. per annum on the preference and 3½ per cent. per annum on the ordinary shares. For the corresponding period of 1894 the distribution on the ordinary shares was at the rate of 2 per cent. The balance carried forward is £2,074, against £1 087.

City of London Electric Lighting Company.—The revenue return for the quarter ended December 31 last shows gross revenue from sale of current for public lighting £3,107 against £3,181 in the corresponding quarter of last year; from sale of current for private lighting, etc., £40,757 against £26,052; from other sources (estimated), £750, against £404; total, £44,614, against £29 637; increase £14,977. Equivalent of 8-c p. lamps connected on December 31, 1895, 195,317, an increase during the quarter of 24,490.

Cardiff.—The Lighting and Electrical Committee of the Corporation have held an enquiry into the circumstances attending the suspension of certain engineers at the central station, and into the grounds for allegations made by these engineers of inefficient conduct of the electrical machinery. After a protracted sitting the committee adjourned in order that the statements *pro* and *con*, may be specifically submitted in writing to a future meeting. The committee intend to call in an independent expert to overhaul the central lighting station, and to report in due time.

Sell's Telegraphic Directory.—The present year's edition of "Sell's Registered Telegraphic Addresses" contains a very large number of alterations which have been effected since the last annual issue was printed. Upwards of 12,000 new registrations, cancellations, and other alterations have been received from the Post Office, in addition to an enormous number of trades, professions, and telephone numbers included in the alphabetical lists, making together upwards of 30,000 individual alterations. The book is admirably planned, and is invaluable as an authentic guide to the largest business houses of the United Kingdom.

Mile End (London).—Mr. B. H. Jenkinson, consulting electrician to the Mile End Guardians, has submitted plans which provide for driving engines and dynamos together for the lighting of the institutions under the control of the Guardians, and it was recently arranged that Mr. Jenkinson should prepare another plan showing the plant arranged in such a manner as would provide for the same quite separately. Both plans were submitted to the Board, who afterwards gave full power to the Works Committee in regard to the provision of electric light, except the expenditure of money and the entering into contracts involving expenditure of money.

Exeter.—An enquiry has been held by Colonel J. Ord Hasted, R E., Local Government Board inspector, with reference to the application by the City Council for sanction to borrow £11,000 for the purchase of the undertaking of the Exeter Electric Lighting Company, Limited, and for the construction of works of electric lighting. The town clerk (Mr. G. R. Shorto) appeared for the City Council, and Messrs. C. T. K. Roberts and S. Andrew for the electric light company, in support of the application, and Mr. Pitt Lewis, Q.C. (instructed by Mr. Campion), for a number of ratepayers to oppose it. The enquiry occupied two days.

Southport—The borough accountant has submitted the following statement to the Town Council: present borrowing powers, £42,822; expended on account of same—arc lighting, £2,581; private lighting, £39,550—total, £42,131; balance unexpended, £691. It has been resolved that application be made to the Local Government Board for power to borrow a sum of £4 000 for the purpose of providing additional mains, service cables, transformers meters, etc. The borough accountant reported that for the year ending December 31 last the expenditure on revenue account had been £2 324. 14s. 3d, and the income £2,113. 19s 9d., or a loss of £210. 14s. 6d.

Gulcher New Electric Light and Power Company, Limited.—The liquidator having applied to the Court for a declaration that Mr. James Murray was liable to pay calls on 300 shares in the Company, counsel were heard by Mr. Justice Vaughan Williams. The respondent admitted that he agreed to take the shares upon condition that 10s. per share was paid up on a large issue of preference shares. That condition not having been fulfilled, he submitted that he was not bound by the agreement. Mr. Justice Vaughan Williams upheld this contention, and dismissed the summons, with costs, to be paid, not personally by the liquidator, but out of the Company's assets.

Edinburgh.—The Lord Provost's Committee of the Town Council have considered a report by a sub-committee on a letter from the general manager of the National Telephone Company, Limited, in which it was recommended that the proposals made by the company, to the effect that the Corporation should lay down underground tubes for telephone wires at the company's expense, should not be entertained. After consideration and a division, the sub committee's report was approved of. A committee of the Town Council have agreed to recommend that the City Chambers and Royal Exchange-square should be lighted by electricity at an estimated cost of £256.

Merthyr—The Parliamentary Committee of the District Council have reported that Mr. J. C. Howell, the promoter of the provisional order for lighting the town with electricity, agreed to make provision for lighting one mile instead of half that distance. The question of the possible purchase of the undertaking by the Council was then discussed, and ultimately certain terms were mentioned which it was thought could be agreed to, and Mr. Howell was asked to embody these terms in a letter to the Council, and if the terms were agreed to the Council would be prepared to give their consent to the order. It was stated that nothing further had been received in regard to the matter.

Long Eaton—The Harrington Lace Factory is now lighted throughout with electricity, the cost of the work having been about £2,400. Messrs. J. H. Holmes and Co., electric light engineers, Newcastle-on-Tyne, have had the contract, and they are now at work at Whiteley's factory. The plant consists of a 70 h.p. Browett and Lindley engine, fitted with all the latest improvements, including patent expansion governors, driving one of the firm's latest type of Castle dynamos. The special feature of the dynamo is the output of 410 amperes at 115 volts. There is an absolute freedom from sparking, combined with small variation of volts from no load to full load. The installation consists of 950 lamps.

Electric Railways in the City.—The City Church Preservation Society has started an agitation against the removal of the church of St Mary Woolnoth in order to provide a site for a station on the extension of the City and South London Railway. It is stated that in the Bill of 1893, which sanctions the extension of the railway, the name of the church to be removed is not mentioned, although the site is clearly indicated, and the parishioners did not realise until quite recently that the church would be swept away. On the other hand, the company say that the removal of the church was well understood when the plans were passed by the local

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authorities, and there is practically no other site available. Moreover, the church is not required. The opposition certainly seems somewhat belated, and as the Act has been obtained it is not easy to see that anything serious can come of it.

Copper.—Messrs. James Lewis and Son's mid-monthly report on copper, dated Liverpool, 16th inst., says: "The first price paid for cash good merchantable copper in the new year was £41 7s. 6d. From this level the value gradually fell away to £40. 10s on the 7th, recovering next day to £41. 6s. 3d., declining to £40. 16s. 3d on the 13th, and closing to-day at £41. 5s. 8d. per ton, after £41. 8s. 9d. had been paid. Had it not been for free selling on American account the last few days, prices would have gone still higher. One thousand five hundred and eighty tons of copper have been purchased by the English Admiralty, and there is no doubt that recent political events will lead to a large increase not only of the British but also of foreign navies, for which a considerable quantity of copper will be required The urgent need of additional telegraph cables has also been shown."

Coventry.—In opening the Gas and Trades Exhibition the Mayor (Alderman Loudon) remarked that they had recently been compelled to introduce electric lighting into Coventry. He said "compelled," because if the Corporation had had their choice in the matter they would rather have waited a time to watch the experience of other towns; but they either had to provide electric lighting themselves, or allow some company to step in, which was not desirable Electric lighting would be the light of the future That being so, it was their duty to encourage the use of gas for other purposes than lighting. The experience of other towns had been that the introduction of electricity had made but very little difference to the consumption of gas. The remaining portion of the electric tramway, from the depôt at Foleshill to Bedworth, has been officially inspected on behalf of the Board of Trade. The section already working is between Coventry Station and the depôt.

Nuneaton —Messrs. Willans and Robinson's new engineering works are well on their way towards completion. The foundry at the far end of the block, which was commenced first, is in a particularly forward state, being practically ready to receive its iron roof. The walls of the machine-shop, too, have been run up to a good height. The necessary excavations for the extra wing are being pushed along with every expedition. Mr. H. Weldon, of Birmingham, who is carrying out the earthworks, has between 70 and 80 men, chiefly navvies, busily engaged on the spot, and to facilitate the work a light tramway has been laid down A smithy is to be constructed, covering a space 200ft. long by 150ft. wide. The testing department has been commenced, and at the east end of the building a chimney, 100ft. high, will be built. The foundations have been already laid, and the walls of a tower for the storage of water to supply the large boilers of this department are now several feet above the ground

Saltash —Some time ago Saltash Town Council gave the gas company six months' notice to cease lighting the public lamps, with a view to making fresh terms, and in due time tenders for lighting the town by gas, electricity, or otherwise were invited Only one tender was received, that of Mr. T. Martin, of Plymouth, to supply the electric light, which the Council did not accept. On January 4, when the date arrived for the gas company to cease their supply, nothing had been decided. The gas company then, on its own responsibility, lighted on another 10 days, so that the Council at their next meeting might have another opportunity of considering the matter. The Council then asked the company to continue the light for six months, but the directors unanimously decided to discontinue the lights, with the result that one evening the town was plunged in darkness. The Town Council held a special meeting the next day and decided to accept the gas company's terms to light the town for 12 months, and the public lamps were once more lighted.

Walsall.—The Electric Lighting Committee report that the works for the supply of electricity for lighting and other purposes had been completed, and that the current was supplied from the generating station in Wolverhampton-street to the public on December 14 Since that date the supply had been continued without any intermission or hitch. In order to compensate the customers for the inconvenience caused by the delay in supplying the light, the committee had decided that no charge should be made against them for the first week's supply, a concession which had been much appreciated. The Streets Committee had had under consideration the correspondence between the Electrical Construction Company, Limited, and the South Staffordshire Tramways Company as to the bad state of the tramway lines. A conference had been arranged between the two companies to discuss the points in dispute. The Town Council have decided to place an additional transformer in St. George's Hall sub-station, at a cost of £600, including the necessary cable

Hanley.—The electricity accounts, as presented by the borough surveyor (Mr. Lobley), for the year ending December 31 show that the revenue amounted to £3,724. 3s. 8d., and the expenditure to £3,623 17s. 1d., showing a balance on the right side of £100 6s. 5d. The actual working expenses amounted to only £2,286. The total sum expended is made up by two important items—viz, £754. 8s. 10d. for interest, and £587. 18s. 10d. to account of principal repaid. The total amount of loans sanctioned by the Board of Trade for electricity works is £46,110. At the close of 1894 the amount borrowed (at 3 per cent.) was £21,645. At the end of December last this amount had been increased to £32,363, and this capital has been expended. A margin of £13,747 remains available for further extensions. The principal items of revenue were: electricity supply, £3,444; meter rents, £75. The profit before setting aside depreciation was £1 443. The statutory price of electricity is 8d. per unit. The price charged last year was 6d. per unit with 5 per cent. discount on prompt payment. The average price obtained is stated at 4·58d The number of units sold last year was 180 000. Preparations are being rapidly pushed forward for lighting Shelton parish church by electricity.

London Lighting Extensions.—Notices under the Electric Lighting Acts and Orders have been given to the London County Council by the Charing Cross and Strand Electricity Supply Corporation to lay mains in Spring-gardens The St. Pancras Vestry have given notice to lay mains in Fortess-road. The Vestry of Hampstead propose to lay mains in Frognal, West End-lane, Oakhill-park, Willoughby-road (east side), Fellows-road (north side), Primrose Hill-road, King's College-road, Dennington-park-road, Greencroft-gardens (north side). A notice, dated December 24, 1895, has been given by the London Electric Supply Corporation, of intention to lay distributing mains, consisting of lead-covered cables in cast-iron pipes, in Duke-street, Grosvenor-square. The County of London and Brush Provincial Electric Lighting Company intend to construct a transformer-box of large size at Windsor-terrace, City-road. The St. James and Pall Mall Electric Light Company have given a notice, dated January 3, of intention to lay mains in Pall Mall-place, and across Pall-mall in two places. A further notice, dated January 3, from the Vestry of St. Pancras was to lay mains across Euston-road. The County Council Committee reported that there was no objection to the notices.

Appointments Vacant.—The Plymouth Corporation invite applications for the office of electrical engineer. Applicants must have had previous experience as electrical engineer to some corporation or company supplying electricity under parliamentary powers, and must be competent to design and to supervise the construction of the generating station, plant, machinery, appliances, and cables necessary to generate and supply electricity for public and private lighting and for power and tramcar traction purposes in a town with a population of 90,000 persons. The gentleman appointed will be required to undertake the management and control under the instructions of the Electricity Committee of the electricity undertaking authorised by the provisional order obtained by the Corporation of Plymouth, and will be required to devote the whole of his time to their service. Salary, £300 per annum, rising by four equal annual increments to £400 per annum. It is desirable that applicants should not be more than 40 nor less than 30 years of age. Canvassing by or on behalf of candidates will operate as a disqualification. Applications, accompanied by copies of not more than four recent testimonials as to character and qualifications, endorsed "Electrical Engineer," must reach Mr. J. H. Ellis, town clerk, Municipal Buildings, Plymouth, by February 14.

Waterloo and City Railway.—The accounts for the half-year ending December 31, 1895, show a capital expenditure during that period of £62,321, making the total outlay £122,736. The works have continued to make good progress. An agreement has been settled with the South-Western Railway Company for the easements required from them for the terminus at Waterloo. Arrangements have also been made with the Central London Railway Company with respect to the City terminus. The engineer reports that during the past six months the works have made steady progress on both sides of the Thames. Towards the City both tunnels are in the London clay beneath the low-level sewer, the Metropolitan District Railway, and Queen Victoria-street, and have reached a point about midway between Benet's-hill and Lambeth-hill, near the College of Arms Towards Waterloo the tunnels have for some time past been driven under compressed air under Stamford-street, and are, on the average, about 150 yards eastward of the junction of the Waterloo Bridge-road with Stamford-street. The total length of single tunnel excavated during the past six months has been 1 635 yards, the total length of single tunnel completed is now 2 835 yards, leaving a total length of single tunnel to be constructed between the terminal stations at either end of the railway of 1,656 yards.

Glasgow.—At a meeting of the Town Council Mr. Guthrie called attention to the fact that the collection of electric lighting rents at this date was £5,389. 8s. 5d, an increase of only £167. 10s. on the previous year, while the collection of gas rents was £125,274. 4s., an increase of £2,149 4s 11d. on the previous year. With reference to the electric light, that statement, he thought, was most discouraging. He knew that many tenants throughout the city were abandoning the electric light, and he impressed upon the convener to lose no time in visiting many towns to secure such information as would make the electric lighting of Glasgow what it should be—a success. Bailie Burt, convener of the committee, deprecated the statements as to the non success of the electric light in Glasgow. He did not think it was fair to run down the system and make comparisons without thoroughly understanding the position. He had no hesitation in saying that the electric lighting of Glasgow had been an unqualified success. They had extended their station, and although they had had difficulties to contend with which added very much to the cost of their street-lighting system, their revenue had been increasing steadily. The matter then dropped. The Tramway Sub-Committee have met to consider the lighting of the tramway cars, but further consideration was postponed in order that Mr. Young, the manager, might have an interview with the company which had originally undertaken to light the cars with electricity.

London County Council.—The Fire Brigade Committee report as follows on the question of establishing electric communication with fire stations: "With a view to reducing the number of false alarms communicated to the brigade from business and other

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establishments in electric communication with fire-engine stations, it was some years ago determined that in future persons who wished to have the privilege of having such communication should not be allowed to use call-bells, but that the communication should be telephonic. The chief officer informs us that there has recently been submitted to him a new form of fire-alarm by means of which an accidental ringing of the bell from contact of wires or other causes can at once be distinguished in a fire station from a proper call, and on his recommendation we have revoked the order prohibiting the introduction of call bells. The chief officer is of opinion that every effort should be made to encourage persons to place their premises in electric communication with fire stations, and with that view he suggests that the annual charge of £5 now made for the privilege should be substantially reduced. Having carefully considered the matter, we have decided to reduce the charge to £2. 2s. a year, and now report our action in order that attention may be directed to the advantage to manufacturers and others of having their premises in direct communication with fire stations, instead of relying in the fire-alarms fixed on the public thoroughfares." Mr. Emden moved, in pursuance of notice: "That it be referred to the Highways Committee to consider and report without delay on the expediency of the Council and the local authorities to construct subways under the streets of London for the reception of the tube and wires of the gas, water, electric, and other companies, and to charge rents for the same." Major Probyn seconded the resolution, which was agreed to, with the addition of a similar reference to the Parliamentary Committee.

Eccles.—We have received a copy of the pamphlet which the Council have issued to the ratepayers giving information on electric lighting, with the committee's reasons for recommending the establishment of works. The pamphlet first gives a history of the movement in the borough, and then goes on to state that 110 local authorities in England and Wales had taken up the question, and in about 40 places the works were already in operation and in no case had a corporation expressed the opinion that they had done wrong. A Local Government Board inspector had told them that the Board were constantly holding enquiries into applications for borrowing powers for extensions of schemes, and he had not met a single instance in which the works had not been a financial success. Testimony such as that was of immense value and reliable beyond any mere casual talk of irresponsible people, and such as ought to satisfy any reasonable man that there was no need for further delay with its attendant risks of the town losing the advantages they had obtained of power to become their own providers of electric light. Comparing their conditions with other boroughs, they were far and away more favourable. Many other towns had gasworks in their own hands and had to compete against themselves; but in Eccles they had no gasworks, and they had a settled certain steady customer in themselves for a revenue of over £1,600 a year, or the equivalent of 3,200 lights at 10s. per light per annum. They had already spent about £1,000, which was a certain loss if they abandoned the scheme. The scheme would provide for lighting the whole of the street lamps in the borough, and for appropriating as revenue to the electric works the actual sum which was at present paid to Salford for street-lighting. They had provided for 1,800 lights, but if that number should not be required the committee would delay spending the full sum until the demand is received. The immediate capital outlay would be £16,471, and the annual charges, including works, maintenance, interest, and sinking fund would be £1,738. They at present paid Salford for gas-lighting £1,665 per annum. If the works were not carried out the provisional order would lapse in June next; the cost of obtaining that order and the previous one (over £1,000) would be thrown away; the £1,000 would have to be paid off by a rate raised immediately (about 2½d. in the £) whereas if the works went on it could be spread over 30 years; and a company would get power to break up their streets as and when they required to lay mains, services, etc., and would practically acquire the exclusive right to supply what was likely to become one of the necessities of the future for illuminating purposes. If the works were carried out the Corporation would establish works under their powers, and acquire for the first time the control of their street-lighting, with the advantage of being able hereafter to improve it at proportionately small expense. The Corporation would be able to run the works and manage them in the interests of the community, studying the advantage of both consumers and ratepayers; the ratepayers would acquire at the end of 30 years, at no cost to the rates in the meantime, a valuable property and business, and there would be no need to lay a rate to wipe out the preliminary charges, as the amount could be borrowed and repaid gradually. Without making any allowance for economy in consumption, or the other economies attendant upon the use of the electric light, it had been demonstrated in several parts of the country that electric light at 6d. per unit equalled gas at 3s. per 1,000 cubic feet; 5d. per unit equalled 2s. 6d. for gas; and 4d. per unit equalled 2s. for gas. The pamphlet, which dealt with the subject most fully, was signed by the members of the Electric Lighting Committee.

Colchester.—The Town Council have thoroughly discussed the electric lighting question, and have now decided to undertake the work and erect the necessary plant and machinery. At the meeting held on January 1 the Council in committee presented a report, in which they stated that they had adopted a special report presented by the Lighting Committee which had been to the effect that an important communication having been received from the officer commanding the Royal Engineers in the Eastern District in reference to the lighting of certain military premises, the Lighting Committee, in view of the letter from the War Department, and that a reply was evidently urgently required, recommended that the provisional order be put into operation, and that they be directed to arrange terms with Mr. Massey, or other technical expert, to prepare a scheme, with specification and plans, on which tenders could be invited from firms of electrical engineers of good standing; to enter into provisional agreements with owners of suitable land on which works might be erected, and obtain plans, specifications, and tenders for the requisite buildings; to prepare particulars for the Local Government Board with a view to application being made for their sanction to the borrowing of the sum required; and to make provisional arrangements with the War Department for the supply of electric light. An additional report stated that Mr. Arthur T. Osborne was willing to sell a piece of land, with stable, adjoining the Stanwell-street depôt for £500, and a piece of land in Stanwell street for £400. A letter from the C R E, stating that the War Office will be prepared to take a supply of electricity for the hospital, was included in the report. Major Skinner, R.E., in reply to a deputation from the committee, stated that the War Department would be prepared to enter into a contract with the Council for the supply of electric light to about 500 lamps at the new military hospital, the price to be charged for the current supplied to be 6d. per Board of Trade unit, the Council to bear the expense of laying the main to a point outside the gates of the hospital, and the supply to be furnished by not later than May next. The committee were of opinion that 6d. per unit was a fair price, and recommended the Council to accept the offer. The committee suggested that a communication be made to the War Department asking that, in the event of the electric light being established, the Council be allowed to supply light in the new infantry barracks, which will probably require about 750 lamps. As to the cost of the work, Mr. W. H. Massey wrote as follows: "If you refer to my report of May 4, 1894, you will see that about £13,000 is put down for street-lighting and private house lighting to the extent of 4,000 or 5,000 lamps fixed; and I don't believe you can do the thing in a creditable way for less, especially at the present time, when the prices of electrical manufactures are a little higher than they were 18 months ago. But if you give up the street arc lighting, which I never recommended in the early stages of central-station working (and which I only included in the estimates at the request of your committee), the difficulty I alluded to in regard to making the electric light pay its way from the beginning, even in the hands of a corporation able to raise capital on easier terms than a company, would be almost entirely removed; and the provision made in the estimated first outlay for arc light apparatus ought to be more than sufficient to cover the cost of mains, etc., for the hospital and barracks, so that a total of £13,000 will most probably enable you to do all that is required (including buildings, etc.,) to begin with. If you secure this extra lighting, there is little doubt but that you would soon be obliged to extend your works to meet the demands in the town itself, and it would, of course, be more profitable to work a £20,000 scheme than a smaller one of £13,000; but in no case would I go in for street-lighting except out of profits. The plans I prepared and sent to Mr. E. Thompson Smith last July will show exactly what can be done as to building a small station, which could be cheaply added to at any time. The remainder of the report consisted of extracts from replies received from boroughs using electricity." The Council, at a special meeting, adopted these two reports, and decided to invite schemes with plans and specifications from four firms of good standing, and to arrange terms with Mr. Massey to advise them upon such plans.

PROVISIONAL PATENTS, 1896.

JANUARY 9.

604. Improvements in insulated anchoring apparatus for use on underground or overhead conductors of electricity. Sydney William Baynes, 33, Haverstock-hill, London.

JANUARY 10.

699. Improvements in electric arc lamps. Harry Neville Moody, 28, Southampton-buildings, Chancery-lane, London.

701. Improvements in electric signalling apparatus. Belisairo Marinovitch, 28, Southampton buildings, Chancery-lane, London.

710. Improvements in and relating to electric accumulators. Audley Charles Miles and Bernhard Fietz de Morgenstern, 151, Strand, London.

711. Improvements in and relating to arc lamps. Audley Charles Miles and Bernhard Fietz de Morgenstern, 151, Strand, London.

712. Improvements in and relating to electric motors. Audley Charles Miles and Bernhard Fietz de Morgenstern, 151, Strand, London.

719. Improvements in electrical accumulators or storage batteries. Benjamin Willcox, 47, Lincoln's-inn-fields, London. (La Société l'Accumulateur Fulmen, France.)

722. Improvements in electric arc lamps. John Isaac Thornycroft and John Edward Thornycroft, 46, Lincoln's-inn-fields, London.

JANUARY 11.

736. Improvements in electric tramways or railways. William Burgess Edgar, 154, St. Vincent-street, Glasgow.

778. Improvements in secondary batteries. Henry William Headland, 77, Chancery-lane, London.

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780. **A new or improved method of manufacturing electrodes for secondary electric batteries.** Henry Leitner, 1, Broad street-buildings, Liverpool-street, London. (Complete specification.)

791. **Improvements in primary voltaic batteries.** William Walker, jun., Frank Richard Wilkins, Jabez Lones, and Charles Vernon 7, Staple inn, London

793. **A new or improved electrical lamp.** Herbert John Dowsing and Henry Sheehy Keating, 28, Southampton-buildings, Chancery-lane, London.

794. **A new or improved electrical lamp.** Herbert John Dowsing and Henry Sheehy Keating, 28, Southampton-buildings, Chancery-lane, London.

810. **Improvements in apparatus for automatically controlling the supply of electricity and gas, water, or other fluids.** Guy Carey Fricker, 46 Lincoln's inn-fields, London.

JANUARY 13.

842. **Improvements in and connected with the manufacture of electric conductors.** Sherard Osborn Cowper-Coles, 16 Adam-street, Manchester-square, London.

845. **Improvements in electrical appliances for automatically preventing railway collisions.** Dominik Weisz and Emil Epstein, 8 Quality-court, Chancery-lane, London. (Complete specification)

868. **Improvements in electric meters.** Carl Raab, 31, High Holborn, London.

879. **Improvements in electric measuring instruments.** Evershed and Vignoles, Limited, and Sydney Evershed, 1 Woodfield-road, Harrow road, London.

880. **Improvements in electric heaters.** George Ewart and John Vaughan-Sherrin, 77, Chancery-lane, London. (Complete specification)

888. **An improved secondary battery or accumulator.** Alfred Upton Alcock, 46, Lincoln's-inn-fields, London

JANUARY 14.

915. **Improvements in electric transformers for alternating currents.** Ernest Scott, The Elms, Bushbury-lane, Wolverhampton.

916. **Safety non-sparking switch.** Ernest Scott and E James Cochrane, The Elms, Bushbury-lane, Wolverhampton.

931. **Improvements in and relating to electrical devices for igniting gas.** James Kerr Semple, 263, Argyle street, Glasgow.

964. **Improvements in telephonic apparatus.** Carl Joseph Schwarze. 45 Southampton-buildings, Chancery-lane, London (Complete specification.)

976. **Improvements in or relating to electric arc lamps.** Henry James Fisher, 70, Chancery-lane, London.

977. **Improvements relating to the synchronising of alternating-current motors for electrical power transmission.** Horace Field Parshall 70, Chancery-lane, London. (Complete specification)

986. **Improvements in the electro-deposition of metals.** John Cameron Graham, 18, Southampton-buildings, Chancery-lane, London.

JANUARY 15.

1006. **Improvements in electrical resistances.** Maximilian Zinner, jun., 4 Corporation-street, Manchester. (Complete specification.)

1037. **Improvements in apparatus for rope railways, "telpherage" lines, tramways, traction, haulage, driving, and like purposes.** Cornelius Edward Kelway, 21 Walbrook, London.

1054. **Improvements in voltaic batteries.** Desmond Gerald Fitz Gerald and Walter Charles Bersey, 53, Chancery-lane, London.

1068. **An improved electrical process for recovering metals from weak solutions and for concentrating the electrolyte.** John Cameron Graham, 18, Southampton-buildings, Chancery lane London.

1069. **Improvements in or connected with electrical condensers.** Charles Pollak, 47, Lincoln's-inn fields, London.

JANUARY 16.

1123. **Improvement of "iron-clad" field magnets.** Thomas Pilkinton, 15, Maryon-road, Charlton, London.

1144. **Improvements in electrodes for electrolytical purposes.** Wilhelm Heraeus, 45, Southampton-buildings, Chancery-lane, London.

JANUARY 17.

1198. **Improvements in electric railways.** John Wesley Darley, jun. 31, Southampton buildings, Chancery-lane, London. (Complete specification.)

1218. **Improvements relating to electric railways.** George Tolmie, 55 Chancery-lane, London.

1230. **Improvements in apparatus for measuring electricity.** Edward Howard Percy Humphreys, 55, Chancery-lane, London.

1237. **Improvements in and relating to electric incandescent lamps.** Charles John Peach Robertson, 6, Bream's-buildings, Chancery-lane, London.

1249. **Improvements in synchronising mechanisms for alternating-current generators.** Horace Field Parshall, 70, Chancery-lane, London.

1238. **Improvements in the manufacture of electric batteries.** Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (Charles Willms, United States.) (Complete specification)

1256. **Improvements in electric choking or impedance coils.** William James Davy, 40, Chancery-lane, London.

JANUARY 18

1310. **Improvements in electrical igniting apparatus.** Hugo Hirst and Arthur Ernest Angold, 88, Queen Victoria-street, London.

SPECIFICATIONS PUBLISHED.

1892.

17092. **Insulating electric wires, etc.** Crompton and Dowsing. (Second edition.)

1893.

259. **Drying paints by electricity.** Crompton and Dowsing. (Second edition.)

1894

4554. **Telephony and telegraphy.** Adams-Randall. (Second edition)

25221. **Dynamo-electric generators, etc.** Atkinson.

1895.

541. **Electric bell and indicator.** Eckstein and Eidsforth.

1262. **Arc lamps.** Davy.

1265. **Galvanometers.** Menges.

1611. **Electric lighting, heating, and ventilating vehicles** Preston and Gill.

3685. **Insulating electric conductors.** Edmunds.

3866. **Electric switches.** Newington and Hewlett.

5041. **Electric steering gear.** Siemens Bros. and Co., Limited, and Grimston

11528. **Electric insulators.** Whitaker and Treharne.

13164. **Dynamos.** Wise. (Maschinenfabrik Oerlikon.)

20028. **Dynamos.** F. J. and R. Chaplin.

22120. **Storage batteries.** Allan and others.

22337. **Incandescent electric lamps.** Edison and Swan United Electric Light Company, Limited, and Hill

22600. **Telegraphic communication.** Kitsée

22696. **Arc lamps.** Thompson (Mathiesen).

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1-1½
—— Non. Cum , 6 per cent. Pref.	2	1⅝ 1⅞
—— 4½ per cent. Debenture Stock	100	112-116
Charing Cross and Strand	5	5¼-5⅝
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7½
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	12¾-13½
—— 6 per cent. Cumulative Pref.	10	15¾-16½
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	3[illegible]-122
—— 5 per cent. Pref. Shares	10	14¾-15½
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10¼-11
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1½-1⅝
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅝ ¾
—— 7 per cent. Cumulative Pref.	2	2-2¼
Elmore's Copper Depositing	2	¼-⅜
Elmore's Wire Company	2	⅜-½
Fowler-Waring Cables	5	¼-⅜
W. T. Henley's Telegraph Works, Ordinary	10	13¾-14½
—— 7 per cent. Preference	10	15½-16¼
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4¼-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	20-21
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7¾-8½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7¾-8¼
Liverpool Overhead Railway	10	11¾-12½
—— 5 per cent. Pref.	10	15¾-16
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅞-1
Metropolitan Electric Supply	10	10¼-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	114-117
National Telephone, Ordinary	5	6-6½
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15½-16½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6⅞
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	8½-9
Oriental, Limited, £1 shares	1	1¼-1⅜
—— £5 Shares	5	7¾-8½
—— £4½ shares	4½	6¼-6⅞
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-106
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8¾-9
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	4⅜-5
Westminster Electric Supply, Ordinary	5	8¾-9½
Yorkshire House-to-House	5	6¾-7½

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NOTES.

Appointment.—Major George A. Carr, R.E., has been selected for appointment as an instructor in electricity at the School of Military Engineering, Chatham, vice Major A. H. Bagnold, whose tenure of the post expires.

Football by Electric Light.—Thames Ironworks have again been playing football by electric light, and this time the affair proved a great success. The Ironworks beat their opponents, Barking Woodville, by six goals to two.

Institution of Civil Engineers.—A special general meeting has been called for February 6 in order to consider propositions for increasing the number of the council, and allowing proxy voting in the election of the council and officers. A supplemental charter will be required to effect the alterations.

Telegraphic Congress.—According to *L'Elettricità*, the Italian Minister of Posts and Telegraphs has submitted several proposals to the Organising Committee of the International Postal and Telegraphic Congress to take place this year at Budapest. The proposals will be in the direction of a reduction of the international tariffs, and possibly of a single rate for the whole of Europe.

South African Cables Again.—The Postal Telegraph authorities announced on Tuesday that the St. Thomas and Loanda cable had been repaired, but that the Aden-Zanzibar cable was again interrupted, so that all telegrams for the South and East Coast of Africa had to be sent by the West Coast route. At the present time these repeated breakdowns are most unfortunate.

Quick-Acting Thermometer.—It is stated in *Wiedemann's Annalen* that the difficulty of obtaining instruments to indicate rapid variations of temperature has induced Herr Paul Czermak, of Graz, to try thermo-elements with very fine wires for meteorological observations. These are found to be superior to thermometers with platinum bulbs, and much better than glass-bulb thermometers, where rapid changes of temperature are to be measured.

Central Supplies.—Dr. Martin Kallman, the Berlin city electrical engineer, has been writing in the *Elektrotechnischer Anzeiger* on the subject of common generating stations as centres for electric lighting, power, and tramway work. In this direction he thinks that there is a great future for electricity, and that the centralisation of the supply of electric energy for all purposes will be an important factor in municipal progress.

Pocket Catalogue.—We have received from the Electrical Power Storage Company, Limited, a copy of their neat little "Pocket Catalogue" for 1896. Its contents comprises a quantity of useful information relative to the company's well-known type of storage cells, besides information *re* their various other manufactures, and several useful tables, etc. The reverse side of each page is squared paper, which feature will render this little catalogue of special value to electrical engineers.

Motor Carriages.—In Scotland the local magistrates do not appear so certain as in England that every self-propelled vehicle is for the purposes of the Highways and Locomotives Act a traction engine, for on Mr. George Johnston being charged at Glasgow with using a horseless carriage in Buchanan-street, the presiding magistrate has taken till to-day (Friday) to consider the matter. The chief point taken by the defendant was the issue of the Excise license, which authorised him to run a carriage propelled by not more than two horses or mules, or by mechanical power. No Excise license was required for a locomotive.

Storage Batteries.—Herr F. Grünwald, writing in the *Elektrotechniker Anzeiger* of January 26 on the subject of the Faure patent, which expires in Germany on February 8, reviews the various steps which led to the discovery of the storage battery, the various forms now produced, and the possibility of their improvement. The conclusion of the article is that the expiration of the patent throws open a wide field for experiment and research. Whether any important results will be obtained cannot be predicted, but it may happen so when the disturbing influence of the monopoly is removed.

A Slight Discrepancy.—The following is taken from the New York *Electrical Engineer*: "The police reports for December to the Board of Administration of Cincinnati were filed a few days ago. The police reported 9,690 hours and 18 minutes' outages, and the Edison Company but 5,241 hours and 20 minutes' outages, a difference of 4,448 hours and 58 minutes. This involves a deduction of 97·88dol. from the Edison Company's bill. The Board decided hereafter to accept the police report as correct and final. There may be litigation on the matter, but the Board feels the position it has taken is demanded by regard for the public interests, and will maintain it."

Proposed Cable to Hawaii.—According to the terms of the Bill introduced by Senator Hale in the United States Senate, the United States Postmaster-General will contract with the Pacific Cable Company for the construction of a telegraph cable between San Francisco and Honolulu, Hawaii. The United States is to pay the company annually a sum equal to 4 per cent. of the amount expended each year by the company. The contract is to continue for 20 years, and the line is to be completed by July 1, 1897. It is also provided that the Government may come into the ownership of the proposed line by paying the cost price for it with 5 per cent. added.

Electric Furnace for Bar Iron.—According to the *Canadian Electrical News*, the Montreal Electric Company have recently put up an electric furnace at the works of Messrs. Peck, Barry, and Co. for heating bar iron intended to be converted into horsenails. The current, at a potential of 1,040 volts, is taken from the mains of the lighting company and is reduced to 20 volts by a Siemens transformer. The furnace itself consists of a carbon tube 2ft. 6in. long and 2in. in diameter. The bar of iron is slid through the tube, which is covered with sand. On a current being passed through the carbon, the iron is rapidly heated, 5ft. of the bar being brought to the proper temperature per minute.

Volta Centenary.—The *Provincia di Como* says that the idea of celebrating the centenary of the invention of the voltaic pile by an electrical exhibition to be held in Como in honour of Alessandro Volta in 1899 has found warm supporters, and there appears every reason to hope that the project will be carried out. When this year's expenditure is discussed by the Municipal Council, it will be proposed to set aside a fixed sum for three years, with the view of forming a nucleus for the exhibition fund, which will be augmented by private subscriptions. It is understood that Prof. Colombo, Signor Ferraris, of Turin, and a number of eminent scientific men are willing to serve on the exhibition committee, and it is also considered that the occasion would be a suitable one for a grand congress of electricians.

Calcium Carbide.—Mr. O. E. Dunlap, writing in the New York *Electrical Engineer*, says that it is expected that before the month ends calcium carbide will be made in the new plant at Niagara Falls. The product of this initial plant will be sent to Philadelphia in barrels and there

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manufactured into acetylene gas to supply Southern Pennsylvania. The new plant here being the first of its kind, many interesting experiments will be made in it. At the starting of operations it will be important to ascertain the amount of electric current which will prove the most economical, for so far the experiments have been made with current varying from 25 h.p. to 235 h.p. The contract of the company with the Niagara Falls Power Company calls for 1,000 or more horse-power. The current is received at 2,200 volts, and used at a voltage of about 100. It is considered probable that calcium carbide will be manufactured at a cost not to exceed 5dol. per ton.

An Unexpected Danger.—Mr. J. B. Foote, writing in the New York *Electrical World* on the subject of generating stations, relates how on one occasion he got into trouble with a static discharge. An alternator and two arc dynamos were being driven by belts from a maple-wood driving-wheel worked by a turbine. "The belts running over the wood driving pulley had no chance to discharge themselves of the static current which they generated, as they were entirely insulated from the ground, but gave no serious trouble until this fall with a very dry atmosphere, the alternator became so charged that the current jumped from the field poles to the armature conductors, making two punctures on exactly opposite sides of the armature. The dynamo current following the static discharge made some brilliant fireworks for a few seconds; the men in charge shut down and put in a new armature, which was no sooner started than the same experience was repeated."

Chemical Society.—At the memorial lecture on the life and work of the late Prof. von Helmholtz, delivered before the Chemical Society by Prof. G. F. Fitzgerald, F.R.S., there was a large audience, including Sir Joseph Lister, Lord Rayleigh, Sir Henry Roscoe, Prof. Armstrong, Dr. Frankland, Prof. Ramsay, and Prof. Roberts-Austen. The lecture dealt mainly with questions of the physical constitution of matter, viewed in relation to theories enunciated by Helmholtz. The lecturer mentioned that the children of his intellect valued most by Helmholtz were his mathematical theories of fluid and vortex motion, and went on to show some of the difficulties inherent in Lord Kelvin's suggestion, based on Helmholtz's theories, that atoms are vortices in a perfect fluid. Passing to the discussion of some of the problems of capillarity, solution, and electrolysis, he concluded by saying that Helmholtz had brought us measurably nearer to an ultimate dynamical explanation of the universe.

Measuring Frequency.—A method of measuring the frequency of an alternating current has been described in the *Zeitschrift für Elektrotechnik* by means of a Mariotte bottle filled with water. The bottle is placed on an iron support about one metre high, and the lower horizontal opening has a diameter of 2mm.; a horseshoe electromagnet, through which the alternating current is passed, is placed near to this iron support, which forms its armature and is therefore set into vibration; for each oscillation a drop of water from the bottle is thrown off, and the stream of water will therefore be separated into a regular series of drops, the number of which per second is equal to double the frequency. If this stream is examined through a stroboscopic disc, it is easy to adjust its speed so that the drops appear to remain stationary. The speed is then measured with a speed counter or by means of a chronographic arrangement. The results of some observations are given, and they are said to be correct within one-sixth per cent.

Electric Towage.—In reference to the bestowal of the Montyon premium upon M. Galliot, of Dijon, for the system of electric towage established by him in one of the sections of the Burgundy Canal, the *Revue Industrielle* remarks that it was not on its electrical side that M. Galliot's work was especially remarkable, since the arrangement adopted was very similar to those already used in overhead tramway work. What, however, took the attention of the commission of awards was that for the first time the power required for traction was obtained from the two weirs at the ends of the section. In reference to this, it may be remarked that, in general, the water supply of a canal is very limited—in fact, only just enough to fill the locks, but in the case of a canalised river where a large amount of water goes over the weirs something of the sort is at least possible, though it might be difficult to work out economically. In the case of the particular section of the Burgundy Canal dealt with by M. Galliot the traffic is not very heavy, and there is a fair amount of water available.

The Hampstead Accident.—The evidence taken by Dr. Danford Thomas at the inquest on the death of Edwin Clarkson at the Hampstead Vestry's central electric lighting station last week, has not brought out very conclusively how the accident came about. Mr. Frederick W. Schiller, an engineer employed by Messrs. Siemens Bros., said that the deceased had made a disconnection when the accident occurred. It was not work in which gloves should be worn, and he could not explain how the accident happened. Mr. G. H. Cottam, the Vestry's electrical engineer, said the current was not on the wire which Clarkson had to disconnect, but it was on an adjacent one, and whilst doing the work he probably handled that wire, at the same time touching an adjoining terminal with the elbow of his other arm. In that way he could have received the shock which caused his death. The jury returned a verdict of accidental death, and suggested that the workmen should be compelled to wear gloves when engaged in any dangerous electrical work. It does not appear that any reference was made to protecting the bare arm. The Vestry was represented by Mr. A. P. Johnson, vestry clerk, and several members were present. Mr. A. J. Cameron, of the Home Office, her Majesty's inspector of factories, also attended.

Manufacture of Light.—A summary is given by *Industries and Iron* of a lecture delivered before the Royal Society of Canada in which Prof. John Cox presented in a very striking way what he terms some unsolved problems in the manufacture of light. He pointed out that in practice not more than from 7 to 16 per cent. of the energy of the fuel used can be realised through the engine, whilst theoretical considerations establish a limit at about 30 per cent., beyond which it would seem to be hopeless to expect to pass in any form of heat engine. He referred to the remarkable efficiency of the dynamo, which is so perfect that scarcely any heat is lost in the current conversion. This represented, in contradistinction to the conversion of coal into energy, the second stage in light manufacture. In the third, that of the incandescent lamp, where it was stated only 7 per cent. of the original energy was available, he remarked that the only means thus far used for producing luminous energy was to heat the molecules of some substance, and in this operation we are compelled to waste the greater portion of our available energy in producing heat before we obtain the light rays. Prof. Cox maintains that even in the arc lamp only from 3 to 5 per cent. of the energy supplied is converted into light, and that, therefore, of the original store of coal less than three parts in a thousand become ultimately useful. If, he said, electrical oscillations could be produced with sufficient rapidity, the molecules of matter might be discarded, and light manufactured without their intervention.

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City and Guilds Institute.—In presenting the prizes to the successful students of the City and Guilds of London Institute for the Advancement of Technical Education, at the Merchant Taylors' Hall, Sir E. Clarke, Q.C., M.P., remarked that an immense deal of money was being wasted in the country on what was called technical education. It was a great misfortune that, through a parliamentary accident a few years ago, sums of money were put at the disposal of bodies who had no experience or knowledge of how they should be expended on technical education. Whatever mistakes might have been made elsewhere in bestowing scholarships on students simply because they had done pretty well in the earlier schools, without regard to their future life or surroundings, the guilds of the City of London had proceeded on the sound advice that they should not attempt to deal with mere manual dexterity or the ordinary sort of capacity. The more the introduction of mechanical, electrical, and chemical science tended to reduce the work of the ordinary labourer to the mere monotonous performance of one simple mechanical act, the more important it was that there should be the highest skill in the direction and management of that labour, and that was the work to which the guilds of the City of London, with a true instinct as to the future, set their minds more than 20 years ago. He hoped that they would never allow their establishment to come under the control, or even much under the influence, of the Government Department. The guilds of London were quite rich enough to maintain that institute for all time as an establishment where the best teaching that science could offer and money could command would be ready for the equipment of the students.

Lighting Railway Trains.—The *Engineering Review* has a long article on this subject. It is remarked that "there is no feature of railway travelling that involves greater comfort or greater discomfort, as the case may be, to the average traveller, than that of a well-lit or a badly-lit train. So much is this the case, that, other things being equal, it may be safe to say that the average passenger will generally prefer to travel by the route that has the best lighted equipment." This is perfectly true, but the trouble is that the railway companies do not seem to be able to realise the fact. Our contemporary, however, adds: "Many different systems of train-lighting are still competing for public favour, but while the oil lamp and the gas jet have had most of the running in the past, it looks as if electricity and the Pintsch, or some other similar system, was to hold the field in the future." Much more progress in this respect has been made in America than in this country, a result that may possibly be due to the very long journeys undertaken there. A dim light such as is supplied by some of the English lines may be put up with for a short run, but something much better is wanted when long periods of time have to be spent in the train. In the United States many different systems of electric train-lighting have been tried, every possible combination of separate or axle-driven dynamo and storage battery having been experimented with, but the use of electric lighting has not extended in the manner that might be expected in view of the fact that the experience of the Chesapeake and Ohio Railway shows that electric lighting (Silvey system) works out 13 per cent. cheaper than Pintsch gas, which is the only formidable competitor from the point of view of a satisfactory light which shall be at the same time reasonably safe.

Gas-Engines.—A paper has been read before the Institution of Civil Engineers by Mr. Dugald Clerk on the subject of gas-engines. Mr. Clerk said that the theory of the gas-engine outlined in a paper read by him before the institution in 1882 was now generally accepted, while the stratification theory had vanished. Great advances had since been made in gas-engine construction, and the heat-efficiency of such engines had been much improved, while the dimensions and power had increased. Engines working on the Otto cycle had been proved to be the best adapted of all yet invented for present needs, and their popularity had gradually led to the extinction of other types. From a mechanical point of view the Otto cycle was a very imperfect one, allowing at most an impulse for every two revolutions of the crankshaft for each single-acting power cylinder, but the mechanical imperfections of the engine had until now been more than compensated by the simplicity of the single cylinder and piston, and the readiness with which the practical conditions of charging, exploding, expanding, and exhausting could be made to comply with the requirements of economical working. The great difficulty of the problems involved in impulse-every-revolution gas-engines was then referred to, and the author described several engines which had been designed with a view to overcome these difficulties. Experiment and theory showed that the efficiency of a gas-engine increased with the dimensions up to a limit which could be calculated. Further economy might be obtained by increasing the compression and expansion, but it was considered that for high compressions and large gas-engines it would be advisable to adopt the compound principle, although the conditions of success, for compound gas-engines, were not yet fully understood.

Electric Power Distribution.—The Chicago *Electrical Journal* gives a report of a paper read by Mr. L. B. Stillwell before the Engineers' Society of Western Pennsylvania at Pittsburg on December 19, on the substitution of electric for steam power, and the consequent abatement of the nuisance which has earned for Pittsburg the pseudonym of the "smoky city." From a series of calculations Mr. Stillwell deduced that in the central wards of Pittsburg and Allegheny a marked saving for the users of power would result, in the case of all but very large steam plants, from the substitution of electric motors supplied with energy from a 20,000-h.p. central station. He suggested two plans, one a central station located 10 miles from the court house and one installed in the city, preferably on the banks of the Monongahela near the coal supply. He considered the second plan the better. To instal a 20,000-h.p. electric plant in the city would cost, Mr. Stillwell estimated, 3,000,000dol., and the total annual charges, including operating expenses, maintenance, taxes, insurance, and interest on investment, would not exceed 600,000dol. Such a plant would be capable of delivering to the premises of the users of power 17,000 h.p. Allowing 3 per cent. for losses in the transformers and 15 per cent. for average losses in the motors installed by the users of power, the plant could deliver at the shafts of these motors 14,000 h.p. at any given time. As all the customers would not always be using the maximum of power which their motors could develop, it should be possible to supply from such a plant motors aggregating not less than 20,000 h.p. Allowing annual dividends of 10 per cent. on the 3,000,000dol investment to be added to the annual charges, making a total of 900,000dol. per annum, the cost per horse-power, calculating that the plant would supply 20,000 h.p., would be 45dol. a year. This figure, Mr. Stillwell said, is considerably under the average cost in Pittsburg, excluding from consideration plants using more than 2,000 h.p.

Fire Risk Rules.—We have already noticed the changes in the rules of the American Underwriters' National Electric Association, but the following four resolutions adopted by the special committee of the association will be new to our readers. They were: "(1)

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That any increase of voltage on interior incandescent lighting circuits would result in a corresponding increase of danger to life and property, and that owing to the tendency toward the introduction of high voltages, it be urged that extreme care be taken by inspectors and others in charge of such installations, without which we believe serious hazards may be incurred; (2) that the members of this committee, and other electrical inspectors here present, pledge ourselves to exert our influence to further the enforcement of the rules and requirements of the National Board of Fire Underwriters, and to co-operate with the Electrical Bureau of said Board in furnishing that bureau with facts that come under our observation regarding devices and materials which may not be constructed in accordance with these rules and the introduction of which would create a hazard to property; (3) that we further agree that all bureau reports received setting forth such facts shall receive careful consideration, and the findings of the report be followed out as far as possible in our respective territories, to the end that co-operative work along these lines may be established and uniformity of action in all essential matters secured; (4) that the introduction of trolley wires in municipal districts is inimical to the safety of the property of the inhabitants of such districts, and that because of this fact all possible precautions should be taken by the managers of trolley roads throughout the country to insure cutting the current off the wires in case of fire in abutting property; also, that trolley wires should be effectually protected against the possibility of contact between them and other conductors; also, that trolley systems should be so arranged that practically no difference of potential due to the effects of trolley roads should exist between subterranean pipes."

New Accumulator.—At the last meeting of the Paris Société des Electriciens a communication was made by M. d'Arsonval in reference to the Blot accumulator. This is made on the Planté system without the addition of oxide paste, and its novelty lies in the form of the plates, which are made of thin ribbons of crimped and grooved lead foil wound round a core so as to make flat bundles or rolls with one diameter very long compared with the other. The ribbon hangs by its own weight, so that within limits it is free to expand, or contract, or change its shape in the process of charging and discharging. This arrangement gives a very large active surface for a comparatively moderate weight of lead, three kilogrammes of metal giving a square metre of surface, or about 61lb. per square foot. The plates are protected by frames made of some metal not attacked by the liquid. M. Blot, the inventor, claims to have attained with plates constructed in this fashion an efficiency of 10 ampere-hours per kilogramme at the ordinary rate of discharge, and this, it appears, may increase with age to 19 ampere-hours. M. d'Arsonval, in his communication, described the results he had obtained from experiments with a Blot accumulator during the past year, and added that these were confirmed by the experience of Mr. Preece at the English Post Office. Mr. Preece, by way of an extreme test, short-circuited a Blot accumulator for 10 minutes so as to give a current of 200 amperes until the E.M.F. fell almost to zero. Then the cells were left for 12 days, and finally recharged to a standard of one ampere per kilogramme. Under these circumstances he obtained an ampere efficiency of 79·2 per cent. and a watt efficiency of 64·8 per cent. The plates were then taken out, washed, and dried. No precipitate was found at the bottom of the cells, and all the plates were in perfect condition. M. d'Arsonval added that the Blot accumulator seemed to lend itself readily to circumstances where the amount of work required was subject to great variations. On the other hand, it could be charged from power sources that were essentially variable and uncertain, such as windmills. He had charged a Blot accumulator on July 14 and left it until October 23, when he found that it had lost hardly any of its charge. Again, he had short-circuited the accumulator for 24 hours without finding any trace of deterioration. This ability to give very heavy currents would be of great service in electro-chemical work. According to figures obtained by M. Margain, the efficiency of the accumulator is 89 per cent. for a rate of one ampere per kilogramme, falling to 45 per cent. at 5·6 amperes per kilogramme. By way of showing the power of the accumulator, the hall was lighted for an hour by a platinum strip kept at incandescence by a current of 100 amperes derived from two cells.

New French Atlantic Cable.—In the January 25th number of *L'Electricien* the Bill for the new Transatlantic cable which has been referred by the Chamber of Deputies to the Budget Committee is printed in full. In the *exposé des motifs* which accompanies the Bill attention is drawn to the insufficiency of the French submarine telegraphic system and the inconvenience of relying on the cables of other countries. To accommodate the French traffic with America and the Continental traffic going through France there is now, it is pointed out, the single French cable from Brest to St. Pierre and the two foreign cables from Brest to Salcombe in England and from Havre to Waterville in Ireland, these two last lines carrying off for the profit of the Anglo-American lines a large amount of traffic which might with better facilities go direct from France. It is further observed that with a single cable it is impossible to guarantee a permanent communication, since the working may be stopped for a time by the slightest accident. The Compagnie Française des Cables Télégraphiques has for several years provided a system of telegraphic communication with places in the Caribbean Sea, and notably with the support of the Government has established connections with the French colonies in the West Indies. For a long time the Compagnie Française has desired a direct communication between this network and the United States, and is now about to carry it out. Under these circumstances the French Government has concluded an agreement with the Compagnie Française by which the latter are within two years to lay a new cable direct from Brest to Cape Cod in the United States, and at the same time to undertake to keep up and renew, when necessary, their existing lines from Brest to St. Pierre and thence to Cape Cod, and also the line from St. Pierre to Cape Canso. The company are also, within two years, to provide a submarine connection between its Atlantic cables and the West Indian lines, so as to complete their network, there being at present no communication between the Atlantic and West Indian portions except over foreign lines. The duration of the agreement is fixed at 30 years, and the Government subvention will be 800,000fr. per annum, but the Government will be entitled to deduct from this sum two-thirds of the excess over 1,650,000fr. of the gross receipts on the working of the Transatlantic cables. Government telegrams are to have preference, and to be carried at a reduction of 75 per cent. on the ordinary rates for the Transatlantic lines, and 50 per cent. on the West Indian lines. If an interruption occurs for more than 24 days on either of the lines constructed under the agreement, the Compagnie Française becomes liable to a fine of 1,000fr. a day counted from the first day of the stoppage, and a fine of 500fr. is imposed under similar conditions for an interruption on the cables between St. Pierre and either Brest, Cape Cod, or Cape

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Canso. If this stoppage lasts nine months the fine becomes one of 1,000fr. a day.

Institution of Junior Engineers.—The eleventh annual dinner of the Institution of Junior Engineers was held on Saturday evening last at the Westminster Palace Hotel. Mr. Archibald Denny, the president, was in the chair. Among the guests present were Sir Donald Currie, M.P., Mr. J. M. Denny, M.P., Mr. James Dunn (acting director of naval construction), Mr. A. J. Durston, C.B. (engineer-in-chief of the navy), Prof. J. Harvard Biles, Prof. C. J. Lambert, Prof. H. J. Spooner, Dr. John Perry, Messrs. E. Windsor Richards and J. M. Gray. In proposing the usual loyal toast, the President referred to the loss sustained by the Royal family in the death of Prince Henry of Battenberg, and Mr. J. M. Dunn, proposing the "Army, Navy, and Auxiliary Forces," said that the prince had died in the service of the country, and his memory should therefore be honoured like any of our past warriors. Mr. A. J. Durston, in reply, said that we could turn out ships in a manner unapproachable by any other country. Not only was our navy superior to all others, but our powers of production were so great that it was only a question of money to keep ahead of other nations in ships and munitions of war to any desired extent. The President then proposed "The Mercantile Marine" in a well-considered speech, which touched on the tremendous strides made in the art of shipbuilding during recent years. Sir Donald Currie, in response, said there was raiding and freebooting in the shipping trade as well as on land, and the dignity of the mercantile marine had sadly depreciated. Ships were not now sailed by the owners, as in the old days, and the competition under chartered rates did away with the personal interest of the owners. No industry had been so legislated against as the shipping industry, but in spite of the spasmodic bursts of humanitarian sentiment England still held her own on the seas. We were, however, behind other nations in valuing the mercantile marine as a serious adjunct to the Royal navy. But just as in the days of Queen Elizabeth the mercantile marine went to the assistance of the navy, so it would do now if occasion required. He regarded the present time as one of great difficulty in South Africa, but he trusted that all would come right. In due time the country would form an estimate of what had been done, and he wished also that the people would understand and comprehend the question at issue and the history of the republics in Africa. We drove the people of the Orange Free State from the arms of England, and formed them into a State against their will, although they begged us to retain them as British subjects. When the people of that Free State got into difficulties with the Basutos we interfered and divided Basutoland between the republic and ourselves, and when diamonds were discovered we took the diamond fields, acting just as we were acting now with regard to the goldfields. Time, kindly consideration, and good feeling gave better solutions of international and social difficulties than did appeals to violence. Other toasts were "Kindred Societies," by Mr. H. Bloomfield Varley, acknowledged by Mr. Richards and Prof. Biles; "The Institution of Junior Engineers," by Mr. A. E. Mavor, acknowledged by Mr. H. A. Young; and "The President," proposed by Mr. W. J. Hunter. The whole proceedings were carried out with a vigour which characterises the Institution of Junior Engineers.

The English Telephone Service.—Mr. Montague Guest has written to the *Times* of Thursday on the subject of telephonic communication. "While the National Telephone Company," he says, "is urging the public to erect telephones in their houses, at an annual rate far in excess of that in other countries, they are not, in my opinion, giving their subscribers the full benefits which are held out to them. It may be correct, and I believe it is so, that a subscriber can telephone to many parts of the United Kingdom, and even Paris, from his own room; but the difficulty arises, how is he to know who is on the system and who is not? The National Telephone Company issues a very meagre book for the metropolitan area, with the names of their subscribers, and in a very few instances their addresses, making it often difficult to be certain that the right subscriber is being called. In regard to any communication with the provinces through the trunk lines, which is held out to the public as an inducement to subscribe, it is well-nigh impossible for the public to find out to what part these trunk lines lead and who are the subscribers at the various towns. It is true that there are supposed to be books in existence which afford this information. I have been in communication, both personally and otherwise, with the National Telephone Company in regard to these books. I was told that they would be supplied at an extra charge of a shilling a book, and that there were five in existence, but though I agreed to take them I have as yet been able to obtain but two—viz., for the Midland province and the Scotland province. I was informed by one of the clerks at the district telephone office that they were very difficult to obtain, as few people wished to telephone into the country. Who can wonder at this when such sparing information is given to the public? Being unable to get a book to refer to I asked if a certain watering-place in the West of England was connected by a trunk line. I was absolutely unable to get any information on the subject. Now, it is absolutely necessary that the public should be able to know with what town and with what people in those towns they can communicate through the telephone. This could be very easily accomplished if the National Telephone Company would publish a book in one volume similar to 'Sell's Registered Telegraphic Addresses,' giving the information required." Mr. Guest adds: "What we want is that the National Telephone Company should realise their position in holding out inducements to the public to subscribe to their system which they are not able to avail themselves of through the neglect of the company in failing to afford the requisite information. There are public telephone offices throughout the country where any person may communicate on the payment of a small fee; but with the very limited information accorded by the National Telephone Company their usefulness is very much abridged." In Manchester the dissatisfaction with the telephone service has resulted in a requisition, which has already received the signatures of 1,000 of the leading firms in Manchester. This will be presented to the Lord Mayor, and his Lordship will be asked to submit it to the City Council. The requisitionists urge the desirability of the Corporation undertaking the telephone service, on the ground that the National Company's system is too expensive, and that the monopoly threatens to increase the present £10 rates. It is urged that the Corporation could now construct telephone exchanges upon a very small outlay; that a service could soon be carried on at a cost not exceeding £5. 10s. per annum for each subscriber; and that the reduced rates would probably lead to the number of subscribers being increased from 4,000 to 6,000, or 10,000 in a very few years. It is pointed out that at Stockholm, which has a quarter of the population of Manchester and Salford, there are 14,000 subscribers, at an average rental of £4 per wire, to the Corporation system. An influential committee of business men has been formed to advance the movement.

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ELECTRICITY AT THE PANTOMIME.

Sir Augustus Harris has long been known as an expert in providing spectacular pantomimes, and year by year it is said that he has surpassed all previous efforts. The continued increase in the use of electricity in these popular entertainments enables him to readily increase and improve on previous efforts. The pantomime "Cinderella," now running at Drury Lane, and drawing houses such as a pantomime hardly ever drew before, contains more than one scene the effect of which is largely due to the use of electricity. Our artist, Mr. W. M. Bowles, has in the accompanying

Scene in the Pantomime of "Cinderella" at Drury Lane Theatre.

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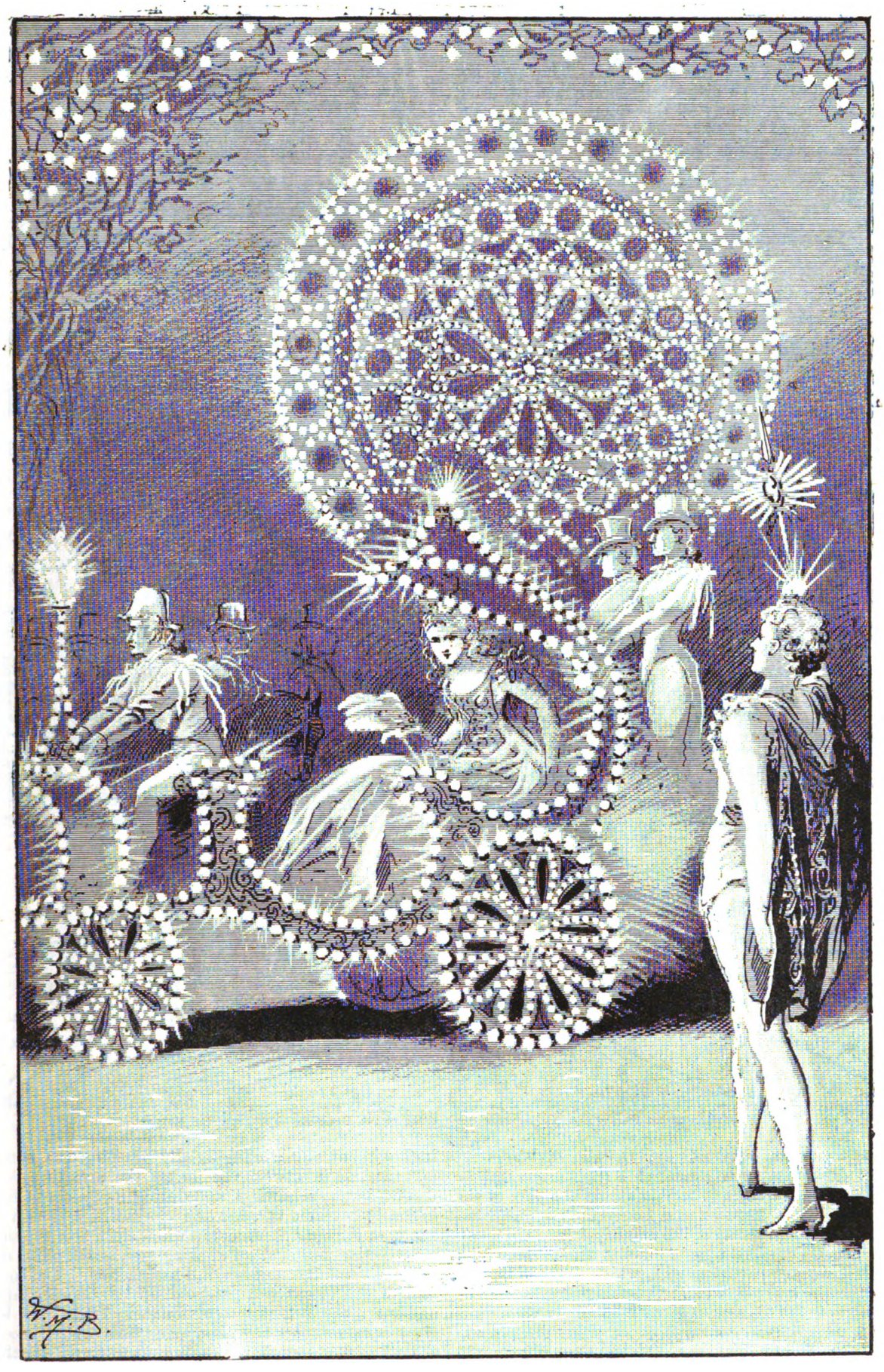
illustrations endeavoured to indicate the use of this illuminant, but no illustrations in black and white can give an adequate idea of the colour glow upon the stage. That must be seen to be realised; but by a strong effort of the imagination our readers may perhaps mentally picture the gorgeousness of such scenes. Our advice, however, would be, do not attempt the mental strain, but go and see the sight.



Scene in the Pantomime of "Cinderella" at Drury Lane Theatre.

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COLOGNE ELECTRICITY WORKS.

(Concluded from page 95.)

Returning to the arrangement of the network, it may be split up into parts by means of 30 mercury switches (Fig. 7). This is necessary for making new connections or repairs, as the network is a closed one. The type of connecting and branching boxes used is shown in Fig. 10. They and the rest of the network have given full satisfaction, requiring only very few repairs, nearly all due to mechanical damage done by the picks of labourers. Fig. 11 is a street plan of Cologne showing the mains now laid.

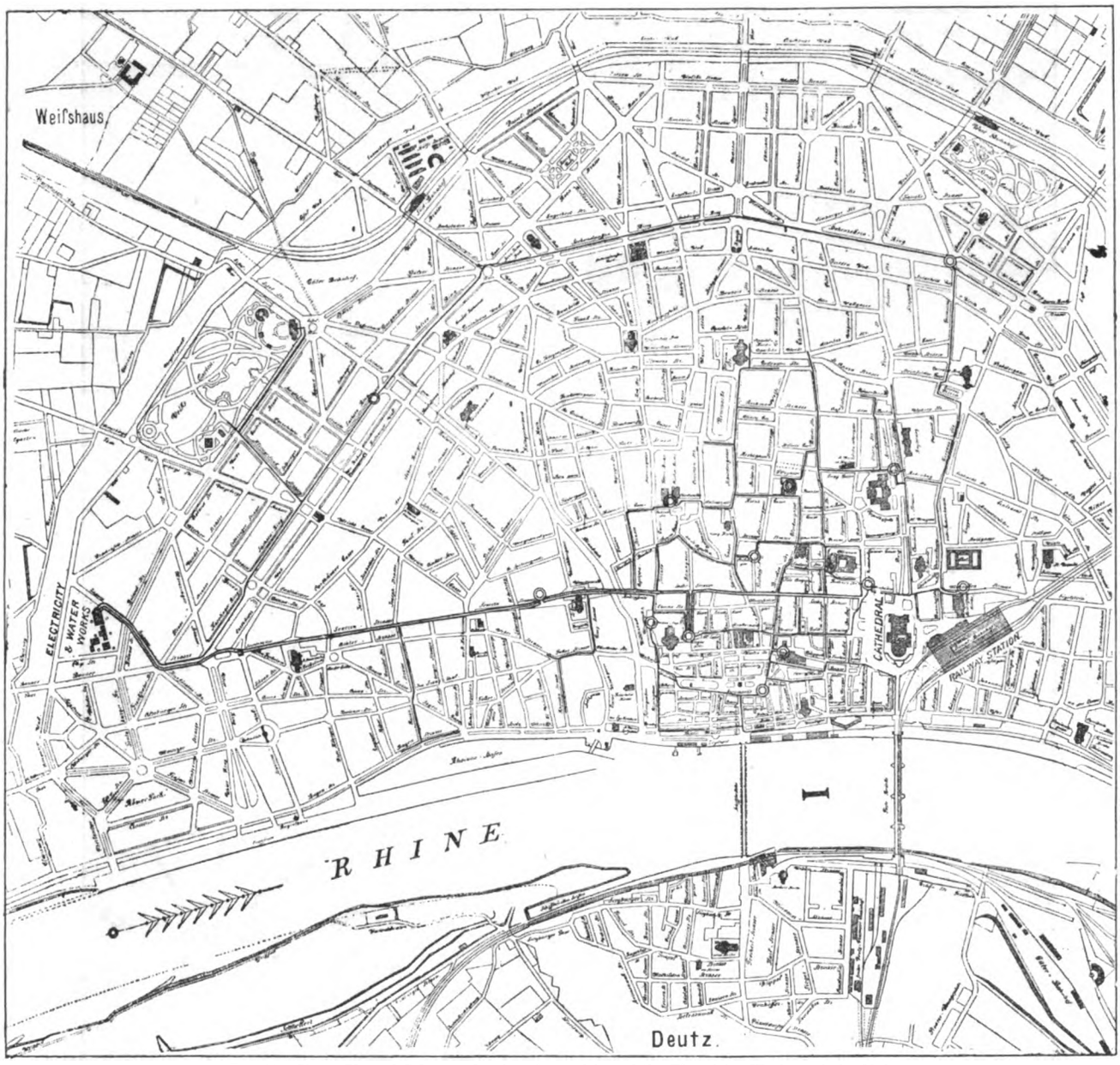

FIG. 11.—Street Plan of Cologne, showing the position of the Electricity Works and the Mains.

TRANSFORMERS, METERS, AND OTHER DEVICES.

Fig. 12 shows the arrangement of a transformer in the cellar of a house, including the T-joint and the part of the primary cable which must be paid for by the customer, but which remains the property of the municipality. The transformer is generally placed upon a bracket, and protected by means of a wooden partition wall, which may be entered only by the station employés. The secondaries of the transformer consist of two coils with 36 or 55 volts, thus allowing a three-wire system with twice those pressures to be used. The 2 × 36 volts are employed especially in conjunction with the Helios Company's arc lamp, which is extensively used in England also, and which gives a steady light with 28 to 30 volts at the terminals. The Helios lamp, which is sold in England by the International Electric Company, of London, has a small inside reflector immediately above the arc, which is protected from the heat by a layer of white enamel. It is almost the only type of alternating-current arc lamp that is used at Cologne for public or for street-lighting. The meters used are of Blathy's patent, and embody a practical form of two-phase motor. Their range is very wide, as the mostly-used 100-ampere type starts with one 16-c.p. lamp, and is correct within 2 per cent. from 5 up to 100 amperes.

Among the other devices used there is the alternate-current clock mentioned before, and represented by the following figures (13-15). It consists of a small synchronous motor, whose field has the special shape shown in Fig. 13, and whose star-shaped armature is built up of iron stampings without any windings. By grasping the button, *a*, and twisting it between the fingers the armature is easily thrown into synchronism, and during its synchronous revolution it actuates directly the clockwork and moves the hands of the clock. Thus the whole clock is of the simplest construction and mode of working, and, as self-oiling devices are employed, it has given full satisfaction. The construction of the motor was patented by Mr. Coerper in 1894, and bears the British patent number, 7,239. As long as there is current in the transformer from whose secondary the field of the clock is supplied, it will run exactly as a similar clock placed in the station; if, therefore, the latter is regulated once a day and brought in exact concordance with a good pendulum clock, all the synchronous clocks of the town will give the right and the same indications. The regulation of the first clock is performed most simply by adding to or lifting from the regulator of the Sulzer

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engine a small weight. The variation of the speed thus produced is too small to be indicated by one of the ordinary tachometers, and is only a small fraction of one revolution per minute.

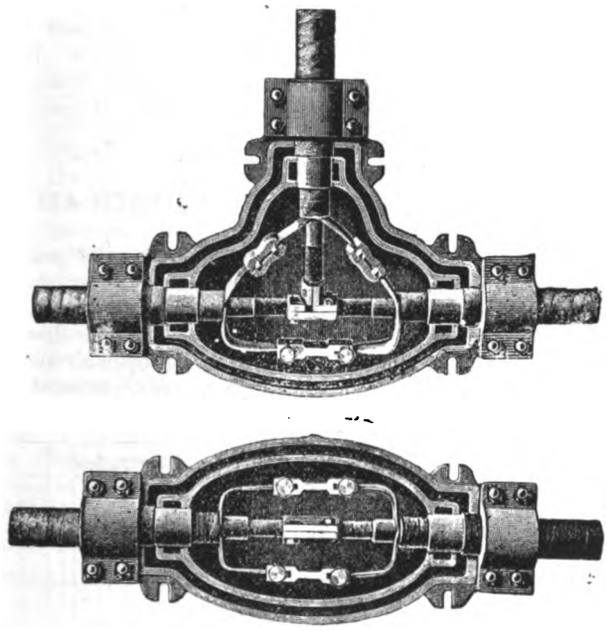


FIG. 10.—House Connecting Boxes.

FIRST COSTS.

The total amount of first costs was £97,424, and was distributed as follows:

Buildings	£21,202	14	0
Engines	11,660	16	0
Boilers	6 232	1	0
Dynamos	23.647	13	0
Network	23,582	0	0
Transformers	7.895	3	0
Meters	1 719	9	0
Measuring apparatus, tools, and instruments	469	8	0
Furniture	130	3	0
Cables and transformers on stock	885	7	0
	£97,424	14	0

It must be noted that there are no first costs for the ground, as the station was erected upon the ground belonging to the waterworks; for this it pays an annual rent of £150 to the waterworks.

FINANCIAL RESULTS.

The price for the kilowatt-hour at first was 80pfg. (9·6d.); on April 1, 1893, it was reduced to 70pfg. (8·4d.), and on July 1 to 25pfg. (3d.) for motive power. Large customers may obtain a rebate according to a somewhat complicated tariff, which was described at some length by one of the authors. The rebate increases by steps with the product of the sum paid into the number of hours during which the whole plant in question is used. Thus, a small plant with a high load-factor, such as a beerhouse, will obtain a higher rebate than the large plant of a private house, whose load-factor is small.

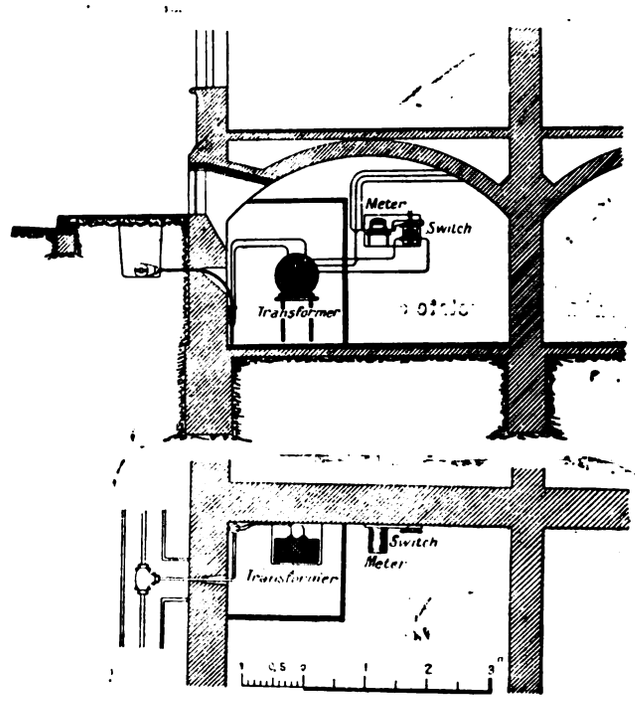
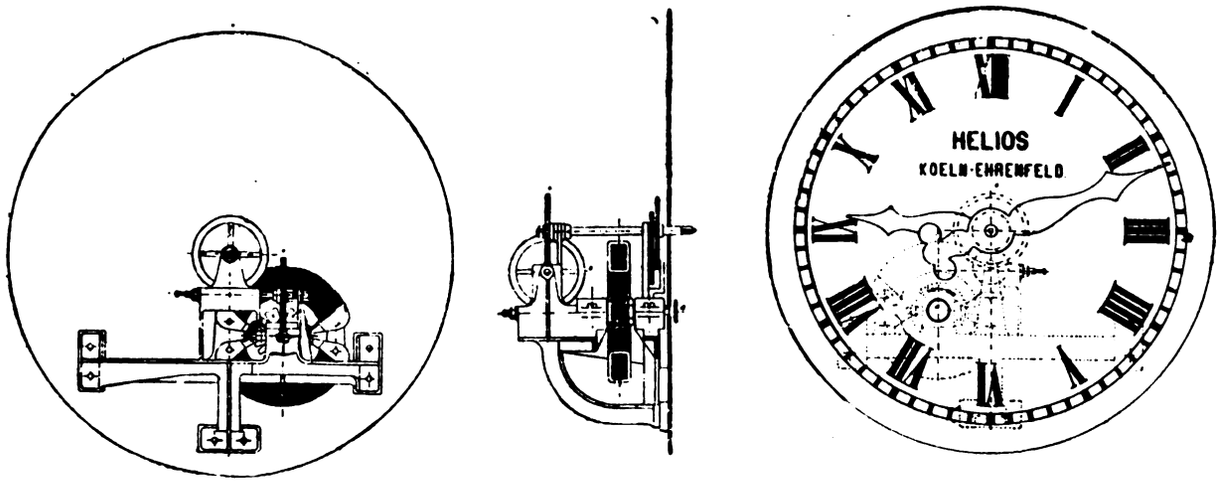


FIG. 12.—Details of Transformer Arrangements in a Private House.

The following Fig. 16 and Table A show the continuous increase of the output and the corresponding decrease of cost of unit produced.

The costs of production are seen to decrease annually corresponding to the increasing output; the irregularity between the second half-year of 1891-92 and the following year is due to the fact that the station did not work day and night within the first half-year, and that a large number of tests were made in 1892-93. The station has no secondary network, but uses at present 260 transformers, with a total capacity of 1,900 kilowatts. In spite of this, the coal bill is not high. This is due to the small losses in transformers and network, and to the high quality of engines and boilers used; and partly also to the fact that these boilers are constantly working with about the same load.



FIGS. 13, 14, AND 15.—Alternate-Current Clock.

Of the total output of the central station, 90·46 per cent. is used by private customers, 88·75 per cent. being used for lighting, and 2·71 per cent. for motive purposes. The public illumination by arcs takes 3·71 per cent. of the output.

It is interesting to compare the relation between gas and electric light. The annual mean of the intensity of an Argand burner, taking 150 litres of Cologne gas per hour,

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TABLE A.—TABLE OF COSTS AND REVENUE.

—	1891 92 Half-year.	1892-93	1893-94	1894-95
Total units sold	154,909	307,075	424,590	568,130
Cost of production in pounds	1,509	3 568	3,297	3 938
Actual receipts in pounds	5,819	10,636	12,854	16,297
Cost of production per unit in pence	2·34	2·78	1·86	1·66
Income per unit in pence	9 05	8·33	7·28	6·88
Cost of coal per unit in pence	·92	·77	·51	·51
Gross profit in pounds	4,310	7,067	9,557	12,359
Net profit	3,061	1,980	4,474	7,052

was 17 amylacetate candles; one cubic metre of gas would therefore be equivalent to $\frac{1{,}000 \times 17}{150} = 112$ candle-hours, if burnt in such a burner. Now, a 50-watt incandescent lamp gives 16 candles; half a hectowatt-hour would thus be equivalent to 16 candle-hours, and therefore one cubic metre of gas would give the same quantity of light as $\frac{112 \times 0{\cdot}5}{16} = 3{\cdot}5$ hectowatt-hours; the quantity measured in lumen-hours, according to Prof. Blondel's propositions, would be $4\pi \cdot 112$, as the amylacetate candle is very nearly equal to Prof. Blondel's pyr, or unit of intensity.* One cubic metre of gas costs 16pfg.; one hectowatt-hour costs 7pfg.; for equal quantities of light the prices are in the relation $\frac{16}{3{\cdot}5 \times 7} = \frac{2}{3}$.

If in this way the total output of the electric station and the gasworks is compared, we easily find that the former amounts at present to 7 per cent. of the latter. Of 1,000 inhabitants only one has the electric light in his rooms, and his plant embraces 64 lamps, while 42 have gaslight, and each installation contains 15 lamps. The total length of electric cables (on April 12, 1895) was 17 miles, that of the gas-pipes was 150 miles; the number of public arcs, which has since been increased, was 15, and the number of public gas lanterns 6,400. The descriptions in this paper are to a large part based upon a book, entitled "Die Beleuchtung und Wasserversorgung der Stadt Köln" ("Lighting and Water Supply of the City of Cologne"), by F. Poly, assisted by E. Froitzheim, Dr. Hansen, and W. Tellmann.

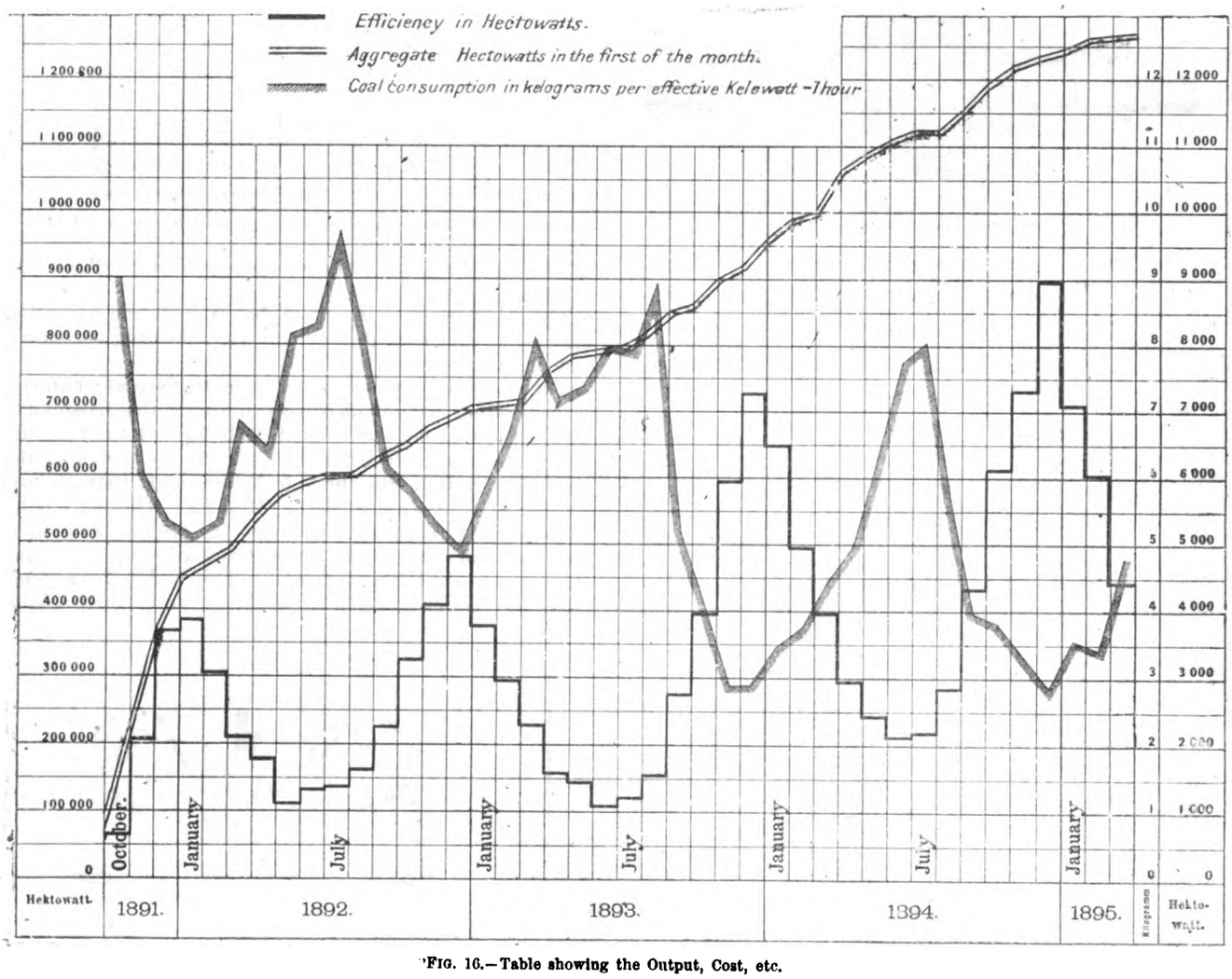

FIG. 16.—Table showing the Output, Cost, etc.

THE MARKS VENTILATED ENCLOSED ARC.*

The shortening of the arc for a given drop of potential due to surrounding the arc by an enclosing medium and excluding oxygen, has made it necessary in the commercial operation of enclosed arcs to employ a higher drop per enclosed arc than would be necessary for open-air arcs, for a certain length of arc is required in order to produce a steady light, and in the case of the enclosed arc a greater potential difference is necessary to secure this length of arc than in the case of the open-air arc. This follows naturally from the increased resistance of the enclosed arc. If the attempt be made to operate the enclosed arc at as low-potential drops as open-air arcs, unsteadiness of the light results. Because of the flattening of the carbon points due to being consumed in the absence of an oxidising agent the light is largely obscured, and the illumination effective only in a small zone. Moreover, if operated at as low a potential drop as an open-air arc, the negative electrode invariably builds and a mushroom-shaped formation results. This formation consists largely of graphitic carbon. The nib thus formed breaks off eventually at its neck, and flickering and unsteadiness of the light results.

* Compare also F. Herzog and C. P. Feldmann, "Vertheilung des Lichtes und der Lampen," Berlin, 1895.

* From the *Electrical Engineer* (New York).

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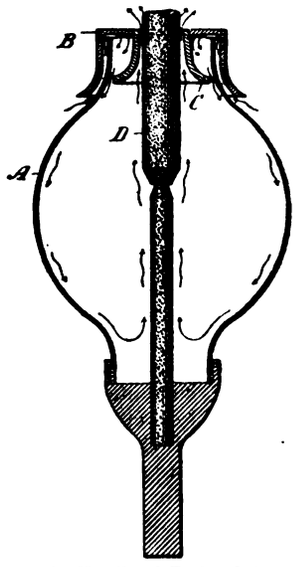
To avoid these difficulties, Mr. Louis B. Marks, of New York, whose work in this field is well known, has designed an envelope in which a limited circulation of air takes place, and which is illustrated in the accompanying engraving. The envelope, A, is provided at the top with a loosely-fitting cap, B, touching the cylinder only at four projections, in the centre of which is a circular or conical tube, C, through which the positive electrode, D, is fed to the arc. The negative electrode, by reason of its slower rate of consumption, may be smaller in diameter than the positive. The outer portion of the cap is enlarged into a bell-shaped flange, the rim of which is brought closely adjacent to the exterior wall of the envelope. Thus there is provided a narrow annular passage for the outside air into the envelope, one of the walls of this passage being formed by the envelope, which, by reason of its high temperature, heats the entering air in transit into the envelope. The tubular opening through which the electrode feeds is made slightly conical in shape, the enlargement at the top being only a little greater than the diameter of the electrode, so as to permit a free feed of the latter and to afford an obstructed egress for gases from the envelope. The lower part of the tube is flanged away from the electrode as shown, this form serving as a deflector for the upward currents around the positive carbon, the flange at the same time forming a deflecting wall for the ingoing air, and directing the latter



Marks Ventilated Enclosed Arc.

outwardly towards the walls of the envelope. The tendency with this arrangement is for all egress to take place by way of the central tubular opening and all ingress by way of the bell-shaped chamber. The arrangement of the cap as above described deflects the ingoing air into the downwardly-moving portion of the convection current, where it is intimately mixed with the gases already formed in the envelope and raised in temperature, so that it is intensely hot by the time it reaches the arc.

A highly important result which follows from the distribution of air currents as described is that the resistance of the arc stream, instead of being considerably increased, as is the case with other enclosed arcs, remains practically the same as in an open-air arc. The length of arc for a given drop of potential is therefore practically the same as that of an open-air arc of the same drop of potential. Because of the flow of convection currents of arc gases admixed with atmospheric air the electrodes do not burn blunt as in ordinary enclosed arcs, but have much the same shape as points formed in open air. The crater formed in the positive is substantially uniform in curvature, while the apex of the negative is quite pointed and well centred with reference to the crater of the positive. Thus there is practically no obscuration of light as in the usual enclosed arcs where the electrodes burn to blunt points. The light is steady and efficient at practically as low drop of potential as with open-air arcs.

Lamps with this type of envelope can be run at 45 or 50 volts, and the carbons have a life of 50 hours.

SOME CHARACTERISTICS OF SYNCHRONOUS MOTORS.*

BY E. KOLBEN.

There are many members of the electrical profession who are of opinion that the synchronous alternating-current motor is a very sensitive driving apparatus, and that it needs careful watching, especially under considerably varying load. Thorough theoretical investigations as to synchronous motors are to hand in great number, but little is known that refers to results under practical working conditions, or to show how greatly this type of motor is capable of being employed even for difficult work. A contribution to the practical knowledge is given below.

Mr. W. M. Mordey, in his paper read before the Institution of Electrical Engineers, February 22, 1893, has already characterised the behaviour of the synchronous single-phase motor with variable excitation in the well-known "V" curve. Far more marked, and more convenient for practical purposes, is the behaviour of the synchronous three-phase motor. Fig. 1 gives the "V" curves of a 15-h.p. three-phase synchronous motor when running with no load and with various loads. Fig. 2 represents the watt consumption of the respective points of the "V" curve, measured by a wattmeter. These curves show, first, that the minimum armature current is found with constant primary pressure for all degrees of load between no load and full load, and even when overloaded under almost constant excitation. Therefore, a regulation of the excitation under even sudden alteration of load is not necessary. Second, that even very considerable deviations in the excitation with any load do

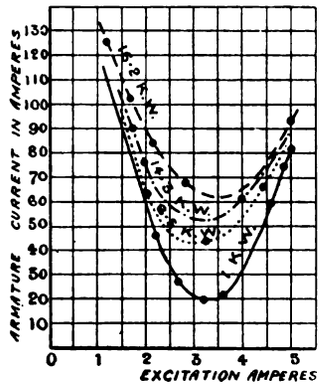


Fig. 1.—Current taken by 15-h.p. Synchronous Motor, with varying excitation at constant loads.

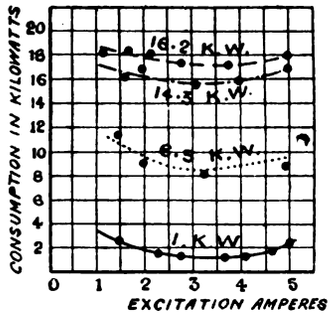


Fig. 2.—Watt Curves for the same 15-h.p. Motor, with varied excitations.

not change the mechanical power of the motor, and that the watt consumption for the same load remains nearly constant: therefore the efficiency of the motor within the extreme limits of excitation is fairly constant.

The most favourable excitation, for instance, in the experiments especially represented in Figs. 1 and 2 amounted to 3·3 amperes, in which case the current and watt consumption becomes a minimum. Given, now, a fall of the excitation current to one ampere, or raised to five amperes, the consumption of current would then suddenly increase at both sides of the most favourable excitation, but the watt consumption would vary very little even in the case of a very strongly over or under excited motor. Of course, this is only a characteristic quality of a good synchronous motor—*i.e.*, such which has only little self-induction, and which, as a generator, would work with a small fall of potential between no load and full load. With a motor with much armature reaction the watt consumption increases extraordinarily with increasing armature current, in consequence of the great reaction of the alternating current in the armature upon the impressed rotating field, as the reacting magnetic field produced by its means creates Foucault currents. How considerable the influence of the armature reaction currents can be is to be seen by the curves of the watt consumption (Figs. 3 and 4) of a good and a bad motor or alternator respectively, when the armature is short-circuited with increasing excitation and armature current. The good watt curve on short-

* From the *Elektrotechnische Zeitschrift*.

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circuit (Fig. 3) includes, besides the losses in copper, which can be neglected, mainly losses of hysteresis. The losses in the bad motor, however (Fig. 4), are principally due to eddy currents. The former has the shape of the well-known hysteresis curve of the 1·6 power, the latter the

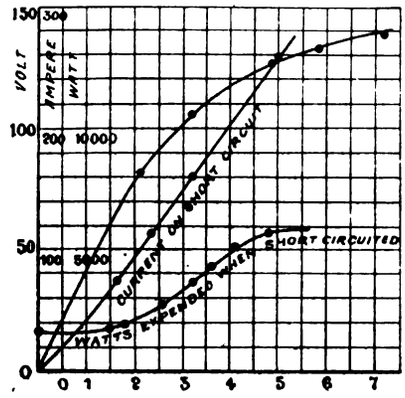

FIG. 3.—Curves for 30-h.p. Three-phase Synchronous Motor.

shape of the eddy-current curve, which rises very quickly with a small increase of excitation.

The value of the machine as a motor and generator can easily be found by the "V" curve, when the synchronous motor runs with no load, and likewise by the short-circuit characteristic curve given below. The steeper the two arms

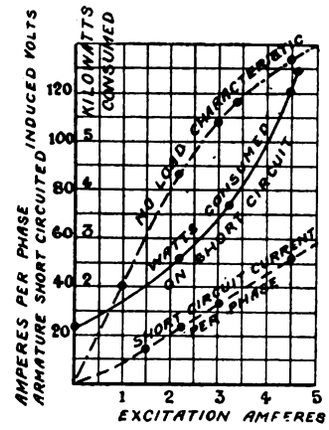

FIG. 4.—Curves for 30-h.p. Motor, with strong armature reaction.

rise—*i.e.*, the quicker the armature current increases with over or under excitation—the better suited is the type of machine, not only as a synchronous motor, as regards falling out of step during sudden load variations, and during overloading, but also as a generator for inductive loads, especially with reference to fall of potential. It is

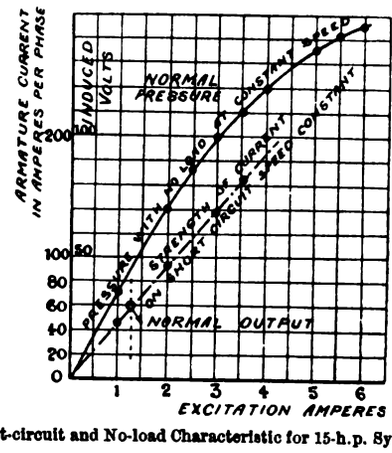

FIG. 5.—Short-circuit and No-load Characteristic for 15-h.p. Synchronous Motor

only such motors, with good "V" curve and short-circuit characteristic, which, as Mr. J. Swinburne suggests, can be used with advantage as no-load current generators, or phase regulators—*i.e.*, as over-excited synchronous motors with no load. The current component having a lead generated thus can be used for supplying big systems, with many smaller and only partly loaded motors, with the wattless or no-load current. In this way the distant transformers and primary machines are relieved of the latter—*i.e.*, no-load current—to the advantage of the whole installation. By this means the efficiency factor (cos ϕ) is increased, and the

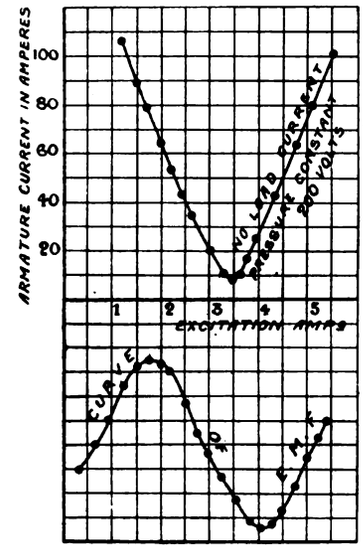

FIG. 6.—"V" Curve and E.M.F. Curve of 15-h.p. Motor, with sine-shaped curve from generator.

otherwise considerable inductive fall of potential in the aforesaid parts of the installation is greatly reduced.

Highly characteristic, as regards the behaviour of the synchronous motor, is the variation found in the armature current when short-circuited with varying excitation. The greater the armature stray field, the smaller will be this strength of current, with otherwise equal excitation, in consequence of the counter E.M.F., produced by the strong counter-field of the armature. The good synchronous motor, which can stand much overloading, has generally a weak armature field, and therefore a short-circuit characteristic, and showing even with small excitation a quickly increasing strength of current. An example of this is shown in Fig. 5, the no-load characteristic with corresponding short-circuit curve of the synchronous motor above mentioned. The following can be taken as a sufficient approximation: The motor can be pronounced good when the armature is short-circuited and the strength of current of full load is reached with an excitation which, with open

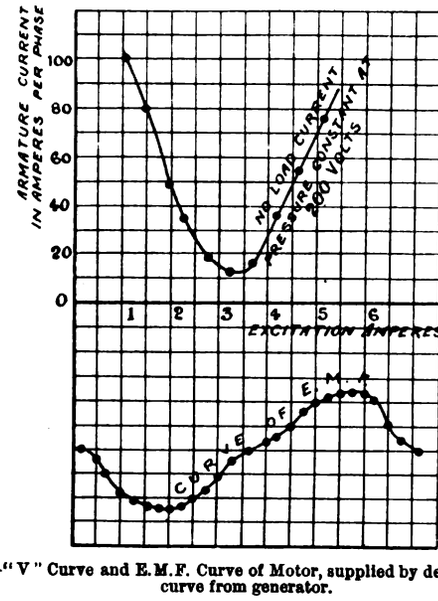

FIG. 7.—"V" Curve and E.M.F. Curve of Motor, supplied by deformed-shaped curve from generator.

armature circuit, would produce about one-third of the normal driving pressure. With the assistance of this useful short-circuit curve the fall of potential of the machine as generator on inductive loads can also be fixed.

The shape of the curve of the E.M.F. of the motor itself, and likewise of the primary machine, is not without

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importance with synchronous motors. In shape the curves will be found to generally agree when the generator and motor are similar to each other in construction. The angle of the "V" curve at minimum point, which has been received from the synchronous motor under most favourable excitation, will then under all loads nearly coincide with the watt current. If, on the other hand, motor and generator vary in construction—one machine, for instance, giving a sine curve of the E.M.F., and the other a deformed pressure curve—then the angle of the "V" curves on all loads will increase, and the efficiency factor ($\cos \phi$) will be reduced even under most favourable excitation, in consequence of the wattless current component of the pressure curve between the two machines.

Their numerical result is easily calculated by graphically detailing the deformed curve into the equivalent sine curve and its threefold harmonics, or wattless components, and then finding out the mean pressure ordinate of the latter,

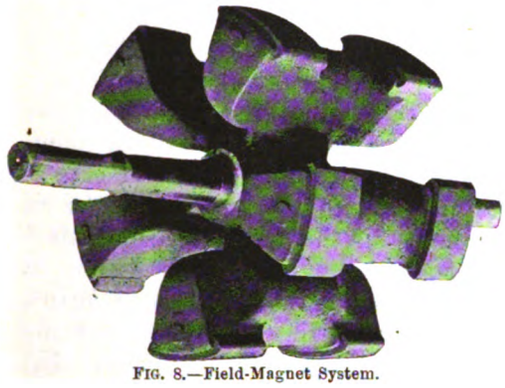

FIG. 8.—Field-Magnet System.

The working of synchronous motors with the various good qualities mentioned above is very simple and certain, if the motors are constructed after the modern type of alternators without rotating winding, thus reducing the supervision and depreciation to a minimum. Fig. 8 gives a view of the rotating parts. Fig. 9 shows a complete 60-h.p.

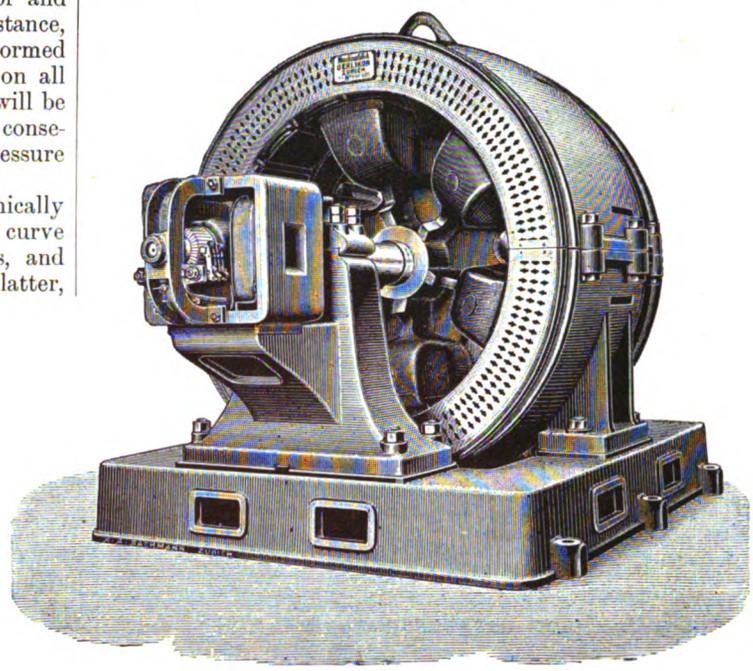

FIG. 9.—Oerlikon 60-h.p. Synchronous Motor.

with the assistance of the no-load E.M.F. characteristic and the corresponding short-circuit current curve (Fig. 4) of the machine fix the resultant strength of current. Figs. 6 and 7 are the "V" curves drawn for variously-shaped curves of the generator, observed on the synchronous motor referred to, which had been taken by the revolving contact

synchronous three-phase motor for 3,000 volts, of the Oerlikon Construction Company's type. In consequence of the good magnetic arrangements of the machine, it can hardly be got out of step, and works with good efficiency, as the energy of excitation is small on account of the one-coil excitation. There is only a small magnetic loss because of

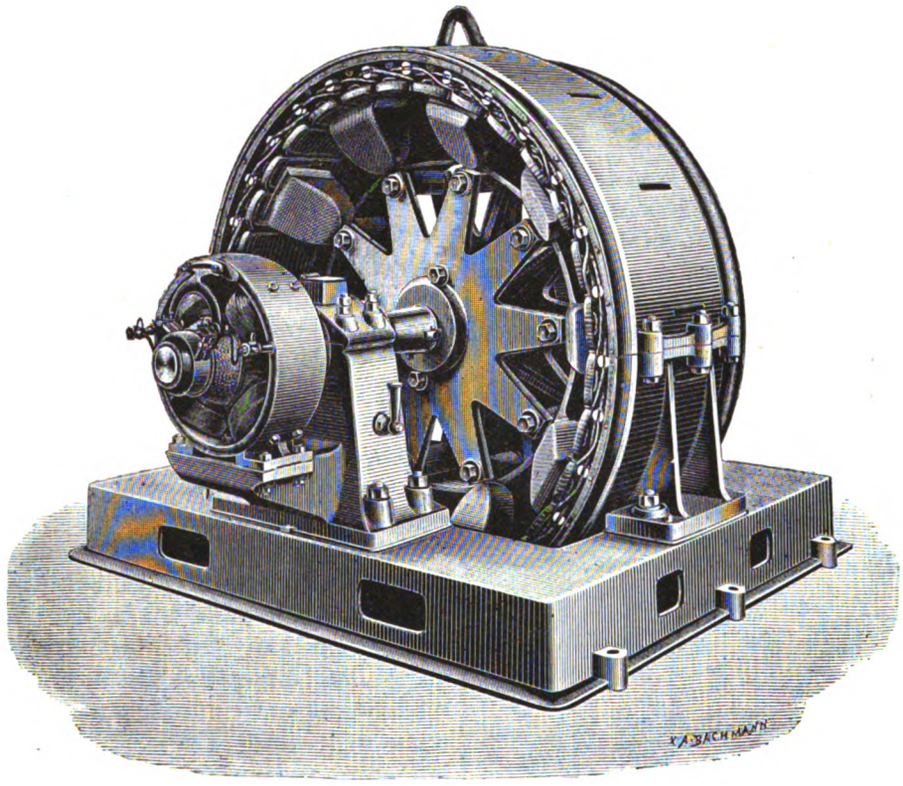

FIG. 10.—Oerlikon 300-h.p. Three-phase Generator.

method. As this method needs a good deal of preparation, it is a good plan, in order to ascertain the value of the pressure curve, to have a small synchronous motor at hand which gives a sine E.M.F. curve. Then take the "V" curve of the same with no load, and see if the strength of current in the angle of it very nearly corresponds with the watt current or not.

the ample dimensions of the armature iron. These qualities make this type of machine also especially valuable as a generator, and its simplicity of construction recommends it equally well for the smallest as well as for very large machines. Fig. 10 represents a larger machine—viz., a 300-h.p. three-phase generator for 5,000 volts pressure, as made by the Oerlikon Construction Company.

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THE

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IN THE COURT.

Compared with the modern society journal, we are pleased to say that technical journalism is free from lawsuits relating to libel. When one does occur it appeals to every professional man as an exceptional circumstance. The case between Mr. Cuthbert Hall and the proprietors of our contemporary the *Electrical Review*—decided in favour of the former on Wednesday—may, we trust, form an excuse for us to touch upon the responsibilities and the difficulties of editors of technical journals, and especially of electrical journals. One of the greatest difficulties is due to thoughtless human nature. Every man has naturally a desire to see criticisms upon works of others, and does not object to adverse criticism in that case, while upon his own works he expects nothing but flattering words. Apply any other words, and he is personally affronted. Let us put the particular case that leads us to moralise on one side for the moment. Upon it a jury has given a verdict, and we desire to say neither yea nor nay to the verdict. What we do wish to point out is this, that respectable journals—journals that assume they have a reputation at stake—are most determinate to criticise a man's public works without intending to impute anything against the man personally. It is seldom that the editorial "we" stands instead of "I," but most often that it really puts concretely an opinion expressed by a number of individuals whose views have been ascertained upon a particular subject. There are questions of public interest, of professional etiquette, of scientific investigation, and so on, that have to be discussed, and it is extremely seldom that one departure from recognised custom will lead to editorial comment, but a particular incident occurring after a number of similar incidents may bring the editorial mind to the position that it determines the subject to be now one of sufficient interest to be discussed with the full weight of the journal's influence on a particular side. Let us take the case just decided as an example of what we are driving at. The older professional men among us can recollect the years in the early eighties. They recollect how dreadfully the general public suffered from the exploitation of patents and companies. If we have read the signs of those times aright and the minds of the men who went through that period of technical journalism, we imagine each of those men will say they fully made up their minds to try to guard the public against hurried investment. Prospectuses and reports became to be looked upon with the direst suspicion. It is extremely easy, then, to realise how imperative the duty seems to be upon the advisers and controllers of technical journals to warn their readers against what they may deem immature or incomplete conclusions. While we cannot but sympathise with any professional man who forms the exception which proves the rule, we cannot help sympathising with brother journalists who we believe hold these views when they make the unfortunate mistake. It is unmitigated nonsense to speak of the responsible controllers of the foremost technical journals as unpractical. We

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think we know the internal economy of many of these publications, and dare venture to say that a more practical body of men could not be found than the men forming the editorial staffs of these journals. They are far more conversant with general progress than any men employed with a particular firm, because they have to investigate a variety of work and not stick to specialities. It is far easier, then, for them to judge the value of a new design or a new invention than most other men, for seldom in design or invention is the departure from what has gone before so great that its value will not previously have been indicated by the attempts made to solve the problem. Most emphatically, again, it is not necessary to have even laboratory or workshop knowledge to condemn certain statements in the strongest language. Let us venture a concrete example, libel or no libel. The *Electrical Journal* of Chicago has the following sentences among others: "Mr. Edison's suggestions for coast defences in case of war are the subject of an article in the New York *World* of December 29. "One suggestion is to run out cables, the extreme end being about fifteen miles from the shore. These cables would run on wheels placed at the bottom of the ocean, and to them at intervals would be attached torpedoes of great destructive power. It is proposed to move the cables back and forth from a subterranean workshop." Now, we cannot justify an adverse criticism of these sentences. We have not tested the matter in a laboratory or otherwise, and yet we do not hesitate to dub the suggestion as enough to damn the author of these as a scientific inexpert. If he is a professional man, he is both ignorant and incompetent. Our readers may remember how Edison's name was used to get up a boom against gas. Now, it has been used again and again for purposes no honest man could praise. Can we, then, as responsible professional men ignore such statements or hesitate a moment in calling attention to their absurdity? We do not believe that Edison himself is concerned in these usages of his name.

Another difficulty in the way of editorial criticism is that the ranks of professional men contain both young and old. The former are lacking experience, but possibly have more energy than the latter? Our own opinion is that the technical journals should constructively as well as destructively criticise; but some men object to be lectured to like schoolboys. Finally, then, we maintain that the higher-class technical papers will not, and do not, allow personal considerations to influence their columns. Their desire is rather to guard the public against capital losses, and to give due credit to every man for his work.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE NEW "RAYS."

SIR,—May I point out that the recent experiments of Prof. Röntgen confirm in a most striking manner the view that you were good enough to allow me to put before your readers, three years ago, as to what electricity, magnetism, electromagnetism, and chemical action really are. As your readers will remember, the view I take is that all of these forces, as well as sound, light, and heat, are modes of motion, either of the molecules of the bodies themselves or of the ether—that they are apparently all wave motions, their different properties varying with their different wave lengths and their different rates of transmission.

Electricity I place not far below the waves we know as invisible heat waves, the infra-red and electromagnetism as above the waves we know as the ultra-violet. That is to say, I view an electric current as a series of waves whose wave lengths are longer than the largest of the invisible heat waves, and whose rate of transmission is lower than that of those waves; while what we know as electromagnetism consists of a series of waves shorter than those we know as the ultra-violet rays, and whose rate of transmission is higher.

Magnetism I look upon also as a wave motion imparted to the molecules of the iron at their formation, or to the ether surrounding and forming part of those molecules, the motions taking place within the closed figures formed by the molecules when the iron is not in the state we call magnetic, and the wave motions being set free by the impressed electromagnetic waves brought to the neighbourhood of the iron by the electric current.

The nature of the motion we know as chemical action is not so easy to place, but it will probably be between the wave length and transmission rate of the highest sound waves and those of electricity. What we know as chemical elements I look upon as matter endowed with special rates, and possibly special forms of motion of their molecules and of the ether, and having special properties in virtue of these special modes of motion. Prof. Röntgen's rays appear to me to occupy a place that might be termed ultra-electromagnetic—that is to say, there will necessarily be a range of motions comprised within what we term electromagnetism, some being comparatively slow in transmission and of comparatively long wave lengths, while others will be of shorter wave lengths and higher rate of transmission. Prof. Röntgen's X rays I believe to be very short electromagnetic waves. It would also be well within probability if some waves are longitudinal and some transversal.

The reasoning that has induced me to take the above views would take long to furnish in detail, but one very striking feature may be mentioned. Whenever we confine bodies in motion without depriving them of the energy in virtue of which they are in motion, we necessarily reduce the amplitude of that motion, shorten its wave length, and at the same time increase its rate of vibration and of transmission. Thus, if a falling body is suddenly brought to rest by impact with the earth, the major portion of its motion of translation is instantly converted into the molecular and ethereal motions we know as sound, heat, and sometimes light. When we heat a body—say, a piece of iron—at first the heat waves are long, and their periods also long, while the rays emanating from the heated body are invisible. As we add heat to the body the waves become shorter and the periods shorter, and this goes on as the body becomes hotter and hotter, the heat waves becoming visible as red, yellow, violet, etc. Also, if we take one of the invisible heat waves and allow it to pass into a body such that the wave motion is confined, instantly the waves become shortened, their period shorter, and the body becomes visibly heated. What we do in the case of the falling body, in the case of the body to which we apply heat, and in that of the body which confines the heat wave, is, we oblige the waves to become shorter and necessarily faster.

And this may be applied to the whole range of molecular and ethereal motions. Pass what we call a current of electricity through a conductor, or, as I understand it, a series of electric waves. While the number of waves passing in a given time is small, or, as we say, while the current density is small, the effect upon the conductor is very trifling; but as we increase the current density, in other words, as we confine the waves, they become shorter, their periods become shorter, and, in fact, they cease to be electric waves; they become heat waves. As we know, we may continue the process by means of suitable apparatus, till, as in the arc, nearly the whole of the electric waves

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are converted into heat and light waves. But there is also necessarily another series of operations going on.

The major portion of the energy, or the motion, present in the electric wave passes by way of the conductor, because it is the easiest path; but, as we know, each wave not only moves forward in one direction—it moves in all directions, one direction being the circular path round the conductor in which the electric wave is passing, with which we are all so familiar. Necessarily, here a transformation takes places, just as a transformation takes place when we add heat continuously to an iron bar, just as a transformation takes place when a falling body strikes the earth, and just as a transformation takes place in the arc, and for the same reason. We have not been able to prevent the escape of the wave entirely, but we have retarded it very considerably, and consequently we have shortened its wave length, and also shortened its period very considerably. If this reasoning is correct, then it must only be a matter of degree to arrive at what Prof. Röntgen has termed his X rays. Further, as the properties of sound waves differ from those of electric waves, and as those of electric waves differ again from heat waves, and heat waves from light waves, each increase in the speed of the vibration, whether of the molecules or of the ether, bringing its own special properties, so we should necessarily expect that as the rate of vibration of the electromagnetic waves increases, so will they develop new properties.

On bringing this matter before an eminent professor a few weeks since, he challenged me to show proof that an electric current is a wave. Here is my answer. Take the case of an electromagnet. When no current is passing round its coils its molecules form closed paths, satisfying each other's attraction, as we say; or, as I prefer, forming paths for the wave motions present. When what we call an electric current passes, the molecules break away from each other, turning in the direction of what we term the lines of force. If the current ceases, the molecules swing back to, or nearly to, their original position. If the current strength is weakened, the molecules turn back partially; if the current is strengthened, they move farther forwards. I think a little consideration will show that the state we call magnetic, the strained position of the molecules, can only be maintained by a succession of impulses following each other in rapid succession, and that these impulses must be furnished by the electric current passing in the coils of the electromagnet. In other words, what we call an electric current is really a series of waves following each other in rapid succession and sending out other waves—the waves we know as electromagnetism—which keep the molecules in a position that is the resultant of the force exercised by these waves and that already present in the molecules themselves. The case of the action of the electromagnet upon the molecules of iron is similar to that of a stream of water falling through a waterwheel, or to that of a ball suspended in mid-air upon the summit of a jet of water.—Yours, etc.,

SYDNEY F. WALKER.

Cardiff Electrical Works, January 20, 1896.

USEFUL INCANDESCENT LAMPS.

SIR,—On the 16th and 17th inst. I read with considerable interest the articles and correspondence in the *Daily Telegraph* on the subject of "Worthless Electric Lamps," and simultaneously with this publication there appeared in the *Electrical Review* a certain advertisement emanating from a firm connected with the trade also tending to disparage German and Continental made incandescent lamps. Referring to your comments on the subject in your issue of the 24th inst., I have reason to believe that both the articles and the advertisements are inspired by the same parties, who, if my suspicions are well founded, are not an English firm, but are themselves "made in Germany," though cloaked with the cover of naturalisation. They have certainly chosen a good time for attacking the manufacturers of their Fatherland.

You will see from my signature that it is in the interests of "fair play" that I take the liberty of submitting to you the following facts, and as a constant user of electric incandescent lamps, I consider myself fully entitled to give my opinion on the subject, which I am in a position to bear out technically.

The electric light, especially the electric incandescent light, is looked upon by most people of sound judgment as a commodity of immense value, both for health and comfort. The extension of electric incandescent light was unduly kept back in England as long as the Edison patents existed here, and more than one of the most prominent electrical engineers of this country hailed the expiration of the aforementioned patents, and the subsequent influx of foreign incandescent lamps, as a blessing and a boon. It stands to reason that besides a great number of thoroughly reliable incandescent lamps imported from Germany, France, Belgium, Holland, and Austria, a certain amount of rubbish was also brought into this country and sold at prices which not only do not admit of a manufacturer's profit, but prove in themselves the bad quality of the merchandise offered. There are, however, firms in existence in Germany and elsewhere who can compete in quality—leaving the matter of price out of the question altogether—with any incandescent lamp made either in America or England.

There is not, perhaps, a single Act or law in existence which has served so much to advertise foreign manufactures in England as the so-called "Merchandise Marks Act," which requires under certain specified circumstances that the goods be marked according to their origin, and the old idea that everything "made in Germany" was bound to be of inferior quality has long ceased to have any truth in it, as I for one strongly maintain that, for instance, the electrical industry, especially as far as electrical tramways and electrical transmission of power is concerned, is infinitely more developed in Germany now than it will be in England for the next 10 years to come. A short visit to Berlin must convince any unprejudiced and technically-trained engineer that a success of such vast importance has been attained which caused the famous Edison himself to remark that even he had considered such technical achievements impossible before he had seen them executed in Germany.

There have been, are, and will be always buyers in England who prefer English goods to those of foreign make, in spite of the higher price. The larger range of customers, however, is only too eager to make the matter of price their first consideration. It is my experience that people who consider it their business to advertise the advisability of employing British labour are the very first who buy for their own home circle foreign-made goods, if they can do so to advantage. The tests to which English and foreign incandescent lamps have been submitted must be considered, from a layman's point of view, utterly unfair, and from an electrical engineer's, downright ridiculous. To test incandescent lamps under admittedly favourable conditions for one lamp and under openly and deliberately unfavourable chosen circumstances for the other, can of course only result in a cheap and unreliable advertisement for the one kind of incandescent lamp, in whose favour the tests have been made, and cannot be regarded as either a reliable or scientifically-conducted test.

In the article on "Worthless Incandescent Lamps" the name of Mr. W. H. Preece, the electrician to the Post Office, has been cited, and there is certainly no more impartial and justly-disposed gentleman in the profession than he, and, in order to put the incandescent lamps of foreign manufacture on their proper merits, nothing could be more desirable than a prolonged and keenly-watched test of all the famous English and Continental lamps conducted under the personal superintendence of Mr. Preece. In order to obtain a fair test, quantities of at least 50 lamps of each make should be tested as regards accurate marking, economy, and life.

I am in the position to prove that a German firm manufacture 15,000 lamps a day, and that they even then cannot cope with their orders. This considerable output sold at a reasonable price proves the quality of the lamp in question, and also that a firm yielding such an enormous turn-out can be more scrupulous in assorting their lamps. I believe there is a good deal in the old English saying, "Call a spade a spade," and I only wish that all manufacturers would mark their goods as what they are—*i.e.*, English or foreign.—Yours, etc.

FAIR PLAY

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DISTRIBUTION OF POWER.

SIR,—In your issue of January 17, page 83, under the heading of Messrs. E. Scott and Mountain, you refer to a large transmission of power plant, shipped to South America, of a capacity of about 160 h.p. It may interest your readers to know that at Messrs. Howard and Bullough, Limited, cotton machinery manufacturers, Globe Works, Accrington, we have a plant for the transmission of power of a capacity of about 450 h.p. This is comprised of two 80-unit and three 60-unit generating dynamos, one balancing transformer, and 51 motors, ranging from 10 h.p. to 30 h.p. This plant is working during the day at an output of about 375 h.p. for 14 hours, and during the night of nine hours at 50 h.p.; the plant is being rapidly extended, as the firm employ about 2,400 men, and no doubt the whole of the machinery will in time be driven by this power. The installation is on the three-wire system.—Yours, etc.,

G. W. SOMERVILLE.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

January 31, 8 p.m.—At Great George-street, Westminster, S.W. Students' meeting. "Ironfounding in Green Sand" and "Malleable Cast Iron," by F. A. Lart.

February 4, 8 p.m. Ordinary meeting. Adjourned discussion on "Recent Developments in Gas-Engines." Monthly ballot for members.

February 6, 4 30 a.m.—Special general meeting to consider a supplemental charter.

Institution of Junior Engineers.

January 31, 2.30 p.m.—Visit to Blackwall Tunnel Works.

February 7, 8 p.m.—Ordinary meeting. "Water Turbines," by F. W. Lowe (member).

Royal Institution of Great Britain.

January 31, 9 p.m.—At Albemarle-street, Piccadilly. "National Biography," by Sidney Lee.

February 7.—"Portrait Painting in its Historical Aspects," by the Hon. John Collier.

Society of Engineers.

February 3, 7.30 p.m —At 17, Victoria-street, Westminster. Inaugural address and presentation of premiums.

North-East Coast Institution of Engineers and Shipbuilders.

February 14, 7.30 p m.—At Lecture Hall of Literary and Philosophical Society, Newcastle-upon-Tyne. Ordinary meeting.

Society of Arts.

February 3, 8 p.m.—At John street, Adelphi. Cantor lecture, on "Alternate Current Transformers." Dr. J. A. Fleming, F.R.S., on "The Testing of Transformers." Lecture III.

February 5, 8 p.m.— Ordinary meeting. "The Mexican Drainage Canal," by Frederick Henry Cheesewright, M.Inst.C.E.

L.C.C. Technical Education Board.

January 31, 7.30 p.m.—At Queen's Hall, Langham-place. Distribution of Certificates by the Duke of Devonshire, K.G.

Electro-Harmonic Society.

January 31, 8 p.m.—At St. James's Hall Restaurant, Regent-street, W. Smoking concert.

THE ARC LIGHT.*

BY PROF. SILVANUS P. THOMPSON, D SC, F R S

LECTURE III.

(Continued from page 101.)

Looking at this device of Staite's, and remembering that he also had a most beautiful wheelwork lamp in 1846, with a differential gear to turn a screw feed one way or the other, we see what a relatively crude thing it was that Foucault brought before the world in 1849. In Foucault's lamp the carbons were horizontal, and were made to approach one another by running on two little trucks, the position of the trucks being governed by cords running over a pulley, one being set by hand and the other one, which moved towards it, being allowed to advance by a cord which was wound up on wheelwork geared to a double train of wheels inside a box. That box had to be wound up by a key like ordinary clockwork, and, having a differential train of wheels, was governed by an automatic arrangement of an electromagnet, with an equaliser on the armature, and working against a spring. If the strength of the current were exactly right to balance that spring, an arm which went up vertically from the pivot stood in a perpendicular position. If the current was too strong, naturally the arm would be turned one way, and if the current were too weak the spring would bring it the other way. The position of this arm determined the question whether the train of wheels inside the box should turn to the right or to the left—whether, in fact, the carbon should be allowed to advance or retreat, or to move neither way if the current was exactly right. Foucault added a beautiful variable resistance, produced by two triangular and diverging pieces of metal dipping into water. As they were raised up near the surface, not only did they offer for conduction a diminished surface, but there was an increased distance between them. The whole contrivance constituted electrically an extremely beautiful arrangement, but mechanically was about as bad as could be conceived, the parts were so diffuse.

In developing this apparatus in later year, after the Serrin lamp had been introduced, Foucault was aided by the mechanical genius of Duboscq. In the well-known Foucault and Duboscq lamp of 1863 there was combined in good shape everything except the variable resistance that there was in the primitive arrangement: the carbons to be propelled towards one another, the differential train of wheels requiring to be wound up by a spring, and the lever which would let off one or other end of the train of wheels, and allow the carbons either to approach or separate, according to whether the current was too weak or too strong.

If one returns to the historical development of this subject the next lamp in order was devised by the architect Archereau, of Rouen, about 1848 or 1850. He had a solenoid with an iron core, acting against a little weight, as shown (Fig. 23). The weight would bring the carbons together, and the solenoid

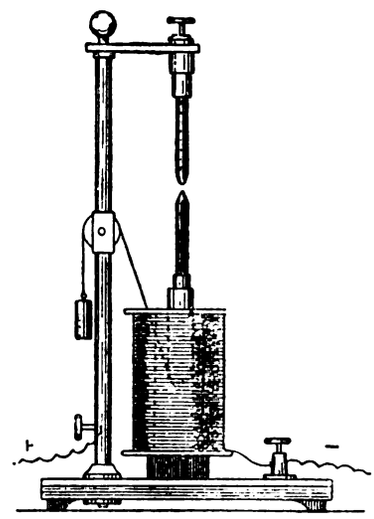

FIG. 23.

would part them. A lamp like this "pumps" very much; it moves up and down, and there is a great flickering in and out when starting, but when you once get it set it may feed very satisfactorily. This may be regarded as the forerunner of all the electric lamps; there is no clockwork; the action merely depends on the balance between gravity and the pull of the electromagnet.

Now let us go at once from these ancient things, which I have merely taken as typical of their kind, to lamps current in 1889. In the closing remarks of my lecture on that occasion I referred to two or three types of lamps as being characteristic of the respective countries, and the last sentence ran thus: "In conclusion, it may be pointed out that there exists a curious sort of family likeness between the several members of the three species of lamps most in use. The rack-train lamps, which may be considered as the prevailing Continental type, are for the most part, in their design and construction, clockmakers' lamps; they have a horological aspect. The clutch lamps, so universal in America, have a sort of sewing-machine look, the working parts being only finished where necessary for actual work, all else being left rough, or merely painted over. The clutch-wheel lamps favoured by British inventors have, in contrast to these, a look as though they had been designed and constructed by a trained engineer; they are essentially engineers' lamps."

That was justified by the comparison of the earlier rack and train clockwork lamps and the American type of clutch lamps, and two in particular of those which had been developed on British soil; and of those two lamps I reproduce the essential features here.

TWO MODERN BRITISH LAMPS.

The first lamp is the lamp which Mr. Crompton, in conjunction with Mr. Crabb, perfected about that time. The principle of its mechanism will be seen from Fig. 24. On the carbon-rod is cut a rack which drives a brake-wheel, or rather a pair

* Cantor lectures delivered before the Society of Arts.

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of brake-wheels one behind the other on the same pinion. The arbor bearing is not fixed in the frame of the lamp, but passes through a short sleeve or jockey, which, when the wheel is free to turn, can slide up or down the carbon-rod, but is prevented from turning sideways by the guide-pin, *g*, above. Below the brake-wheels is a lever, L, pivoted at *o*, and attached by a link, H, to the core of the solenoid overhead. This lever carries a small table, *t*, and brake-piece, *b*, faced with phosphor bronze. When the lamp is out of action the free end of the lever is down, and the weight of the wheels and the carbon-holder bears down upon the table, *t*, by means of the pin, *p*, which projects from the jockey sleeve. In this position the wheels do not touch the brake-piece, *b*, and are free to rotate so that the carbon-rod is free and the carbons are together. When the current is turned on, the main current coil attracts its core, first drawing up the lever, which, turning on its pivot as it rises, brings the brake-piece against the rim of the brake-wheels and prevents them from rotating. Any further rise of the lever lifts the brake-wheel jockey and carbon-holder, thus striking the arc. As the arc burns away and the shunt coil comes into action, the lever descends slowly feeding the arc as required, and before it gets to the end of its tether the brake-wheels are released and feeding takes place by the release of the carbon-rod, the inertia of the wheels preventing any jerky motion.

Contrast that with the corresponding part of the well-known Brockie-Pell lamp. That lamp was already at that time a famous lamp, and has more than justified its existence since. It had also a brake-wheel, driven straight off the rack of the carbon-rod; and the brake that played against this wheel was a small projection, with a bit of leather or indiarubber round it, which was pressed in against the inner side of the rim of the wheel. There was loosely pivoted to the same centre a large

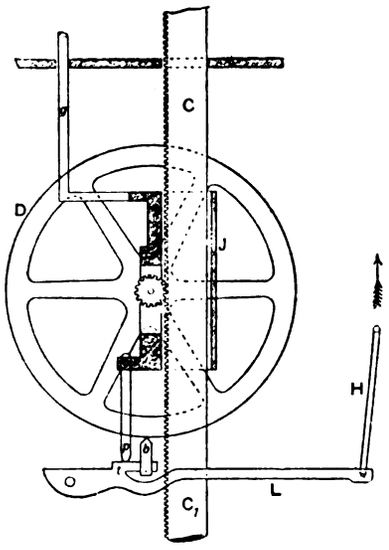

FIG. 24.

sector piece, which, as a matter of fact, was weighted, to make it heavy; and upon that sector piece there was pivoted an auxiliary lever, which was worked by a see-saw overhead, the see-saw itself being operated by two cores, which ascended into a solenoid. One core, in a main circuit solenoid, pulled up, and the other core, in a shunt solenoid, opposed it. Suppose the main current is very strong at the moment of striking the arc, this core is pulled violently up. The first thing that happens, then, is that the auxiliary lever is caught at its tail by a fixed piece, and turns round on its pivot, raising the weight, and clamping the little brake-piece against the interior part of the wheel, and then, if there is any further rise, they rise solidly together—that is to say, the auxiliary lever, the heavy sector, and the wheel all rise together about a centre, and raise the carbon, and strike the arc; in fact, one has a kind of internal toggle brake against the rim of the brake-wheel.

About this time Mr. Brockie modified his mechanism, and put the little brake outside instead of inside, and he has made various detailed improvements since, and has brought out several patterns of lamps. Here is one of the forms of brake-wheels now employed in one of the many lamps made by Messrs. Johnson and Phillips, under Mr. Brockie's superintendence. In this case the upper and lower carbons are carried by flexible cords, which pass over two pulleys rigidly fastened together, but electrically insulated at the back of the wheel. The wheel in this case is put at the top of the mechanism of the lamp, instead of being at the bottom. The electrical action has to perform the following function. When it attempts to raise the long lever which is sprung across the middle, the little auxiliary lever causes the brake-piece to bite against the inside; they are gripped together tight, and the whole thing has to go round together. When the long lever is let down, however, owing to the small auxiliary lever descending with its tail upon a fixed point, the grip is released, the wheel can turn, and the arc can feed little by little as the motion allows the wheel to turn. To strike the arc, it has to turn a little backwards; to feed, it must be allowed to creep forward as wanted by imperceptible degrees. A similar sort of arrangement of a clutch against the moving part Mr. Brockie has used in another pattern of lamp, which is favoured by the Post Office, wherein there is no brake-wheel; the clutch works in that case on a perpendicular rod.

I believe that all the inventors of arc lamps go through a species of evolution themselves. Take almost any one of the many names in arc lamp work—take Mr. Brockie as an example, or Mr. Crompton, or almost any other—and you will find that the inventor is never satisfied with his first performance. He is impelled to go on, and the record of almost any one of these men will show that they have tried successively various types, and have gone on, sometimes on one line, sometimes on another, developing and perfecting, until they got something very near perfection indeed. The brake that Mr. Brockie has in this lamp is, I suppose, about as near perfection for minute feeding as any brake applied to the rim of a wheel could possibly be. I alluded just now to one feature of the Brockie-Pell lamp—the use of the see-saw piece. This see-saw is a lever operated by two iron cores going up into solenoids, one of which is included in the main circuit, while the other is joined as a shunt.

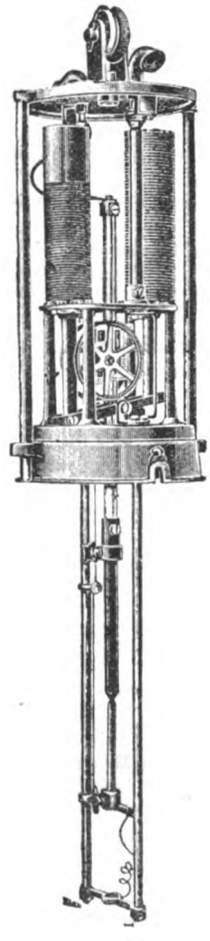

FIG. 25.

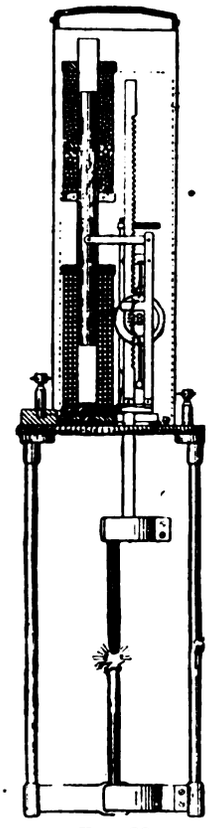

FIG. 26.

It was no new thing in 1889 to have a differential motion in a lamp. The first one was about 1855. The well-known Brush arc lamp had differential winding on the electro-magnet, the series and shunt coils working against one another. Even earlier than that Siemens had a differential solenoid working at the two ends of a straight core—the series coil trying to pull the core down, the shunt coil trying to pull the core up; but so far as I am aware, the special advantage of this see-saw arrangement with a shunt at one end and a series at the other was in 1889 not generally recognised. True, it existed in the Thomson-Houston lamp and in the Brockie-Pell, but scarcely in any other lamps. Now the real advantage of using a see-saw over a differential winding or over a differential plunger is this: that in this case when both the opposing parts are fully in action, when the main circuit coil only is pulling hard at *a*, the shunt coil is pulling hard at *b*, the lever is subjected to considerable forces, nearly balancing one another, and any small difference arising from any change of the current in either coil would be quite sufficient to produce the required movement action. Even if there were friction in the parts the movement will occur with certainty, because the forces balancing one another are comparatively large mechanical forces. Whereas in the American plan of using a differential winding, when the two coils have their magnetising effect nearly in balance, the mag-

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netism is almost zero, and, therefore, the forces are almost zero; and hence the mechanical effect is comparatively at a disadvantage in contending with any tendency of the mechanism to stick. Friction plays a much more important part in determining whether the feeding apparatus is or is not to act in those lamps where you do not utilise to the full the mechanical value of both the currents—that in the main circuit coil and that in the shunt coil. Here, in the see-saw, they are utilised to the full. It is quite remarkable how the see-saw mechanism has, since 1889, grown into favour with other inventors. Kent's lamp, for instance, has a see-saw. At one end there is a shunt electromagnet, and at the other a series electromagnet. The see-saw is between the two, so that the mechanical pull of both coils is utilised to the greatest extent.

In Fig. 25 we have the Crompton-Pochin lamp—of which the brake-wheel part is practically identical with the Crompton-Crabb brake-wheel (Fig. 24); but instead of having a long solenoid, with an iron core, to be pulled by a lever, there is a series coil and a shunt coil at the top of the lever working the see-saw. One might point to other lamps of modern type, in which the same see-saw arrangement has survived the less effective forms. In the latest Crompton-Pochin lamp the see-saw operates a hand brake. The lamp hanging before you is the form of lamp now produced by the Brush Company, under the name of the Brush-Vienna lamp. I belive the greater part of its mechanism is due to Mr. Kremenetsky, of Vienna. It has a series coil, and a shunt coil, and a see-saw working between them. As in many other Continental lamps in which clockwork or wheelwork is still employed, the operation of the electromagnets of the lamp is to rock over the clockwork bodily, both for striking the arc and for determining whether the feed shall occur or not. You will find that in a very large number of lamps that have developed of late years, the question whether the train of mechanism shall or shall not be permitted to turn is made to depend on the position of the wheelwork as a whole, and the wheelwork is turned round on some convenient axis. One's mind travels back to 1882, at the time of the Crystal Palace exhibition, when there was a lamp with tilting clockwork in it, shown by Mr. Brockie; a lamp which was never extensively employed, because Mr. Brockie went on to higher things.

Development of Siemens's Lamps.

We have here, amongst other pictures, a whole series of German lamps developed by the house of Siemens, illustrating the progress of invention so far as that firm are concerned.

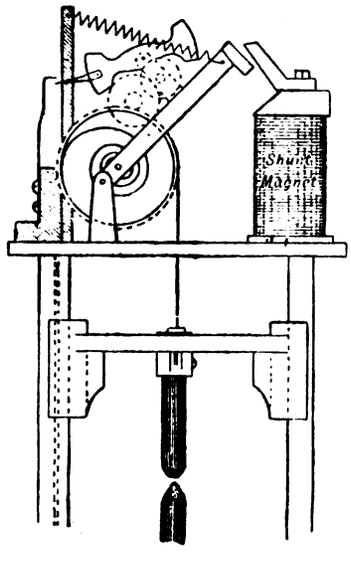

Fig. 27.

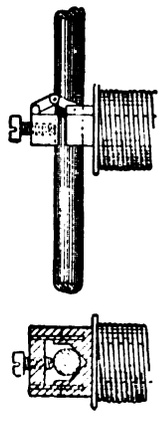

Fig. 28.

In one of these (Fig. 26) the differential principle is introduced. The upper carbon is supported by a rod on which teeth are cut, which engage with a small pinion mounted on a frame. The pinion is only allowed to turn by driving a pendulum by means of an escapement, so that the feed will go on slowly but continuously so long as the series coil is not in action. When the current is turned on, the frame containing the escapement and carbon-rod is lifted, striking the arc, and the top of the pendulum becomes fixed in a little nick. If the arc burns too long the shunt coil brings down the frame, giving immediate relief, and when the frame has moved a little distance the pendulum is released, which, in slowly allowing the escapement to operate, gives permanent relief by feeding the carbon forward.

Now we come to the "flat-topped" lamp. It was a great thing to get rid of these very long carbon-rods with their racks, as they took up so much vertical space. In this lamp the carbons were simply clamped to a cross-piece, top and bottom. The top cross-piece was gradually screwed down by an arrangement with a gear vibrating, almost like an electric bell mechanism, which took up a wheel tooth by tooth, and so drove the screw feed down. This was the precursor of a much more important lamp that the firm of Siemens has been putting out for the last half-dozen years.

In Siemens's "band lamp" (shown in Fig. 27) we see that the carbon is clamped into a heavy holder; there is no long carbon-rod, the carbon is suspended on a flexible band or cord of woven copper, that goes over a drum, inside which there is a spring. The weight must be so heavy that it will uncoil that spring, and when you lift it up to put in a new carbon the spring coils itself up again. This mechanism has two toothed wheels to multiply motion, and then an escapement (with a little piece sticking out at the end of it), and the whole is carried on a frame, which can be tilted. This, again, brings us back to the tilting wheelwork which Mr. Brockie had in 1882. In the present case the only magnet is a shunt-wound electromagnet working against a spring. Supposing there is no current supplied to the lamp, that magnet does not pull; the spring pulls back the frame, and the clockwork is locked. When the lamp is put on a circuit, there is no way through it except through the shunt, the magnet will therefore pull the armature forward, which motion will lower the upper carbon a little towards the lower carbon, and make them touch; or, if they do not touch, it releases the escapement, and that will work, letting the upper carbon descend until they touch. The moment the main circuit is thus completed, there will be less current going round the shunt; the spring will therefore rise, and the clockwork will be locked until such time as it is necessary for feeding to occur.

A Belgian lamp, described in 1889, illustrates this feature of the rack and wheel work turning on a pivot, which is so often found in Continental lamps.

The exclusive use of a shunt coil without any main circuit coil, though it was not well known, is a feature which has existed a long time. There was the Lontin lamp of 1877, a variety of the Serrin. This is the first case of a lamp working only by a shunt coil. The Serrin had a series coil to pull down a jointed parallelogram to prevent the feed occurring. In the case of the Lontin lamp the jointed parallelogram was raised by the operation of the shunt coil, and the feeding mechanism released, which otherwise was locked when the frame descended by its own weight. Many lamps with shunt coil only are now in use.

Improvements in Clutch Lamps.

There are a few other types which have developed since 1889, amongst them the clutch lamps. The next few diagrams relate to clutches that have been developed since that time. The first (Fig. 28) is that of the Helios Company. Here the actual carbon comes down in front of the pole of an electromagnet, which has a deep groove in it against which the carbon slides. A small iron armature with an adjusting screw is made to grip against that carbon rod with a sort of knee-joint above, and holds the carbon rod as long as that electromagnet does its duty, but as soon as the electromagnet ceases to pull, as can be arranged by differential winding, the clutch releases the carbon rod, lets it slide a little bit, and then catches it again. This necessitates

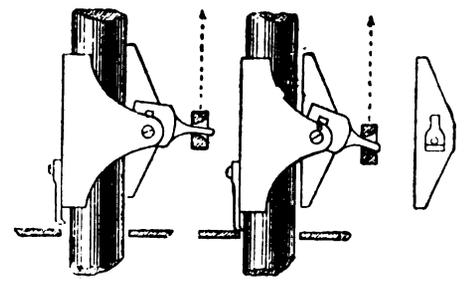

Fig. 29.

an independent arrangement for striking, but it is interesting as a form of clutch.

Then we come to the improvement in 1893 of the Brush lamp by Mr. Adams, one of the engineers of the Brush Company in Cleveland. In the old Brush the clutch was a simple ring or washer, which gripped the carbon rod and raised it. That was replaced by Mr. Adams by a nipping clutch (Fig. 29) with a separate toggle-joint arrangement, which in one position pulls the clutch-piece away from the carbon rod and allows it to slip, and in the other position nips it against the rod and holds it up. The question whether the brake-piece is to be allowed to advance towards the rod and hold it, or to retreat from it, depends upon the position of the arm which comes down from the solenoid above, and depends on the larger portion of the clutch being allowed to come down into contact with the floor of the mechanism of the lamp. I have here for exhibition two lamps of the Brush Company's manufacture. One is an example of the Brush-Adams lamp, the other a Brush alternating-current

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lamp, with laminated iron cores for the solenoids, and having the old kind of clutch.

HELIOS ARC LAMP.

Another lamp here, which has tilting clockwork, is kindly sent me by the Helios Company. We have here the feature of the two coils, series and shunt, and a kind of see-saw. The operation of that see-saw is, however, to tilt a train of wheels, and the question whether those wheels shall be allowed to turn round or not depends on the amount the clockwork is tilted over, so that that combines the Continental feature now so common of the see-saw. This also is an alternate-current lamp; but it has the novel feature of an enamelled iron reflector set just above the end of the upper carbon, and surrounding it, so as to throw downwards (as shown in Fig. 12) the light that otherwise would be projected obliquely upwards. A quite small mirror, fastened on a bridge between the rods that form the frame of the lamp, suffices for this purpose.

THE PLANET COMPANY'S ARC LAMPS.

Another type of lamp has been developed by the Planet Electrical Engineering Company, of London. A motor is made to turn one way or the other, according as the voltage of the lamp exceeds or falls short of the prescribed amount, and the motor drives a feeding-screw. I have been using a Planet lamp in these lectures when illustrating the Trotter phenomenon. It is one of the compact little lamps which the Planet Company is now making specially for projector work, with a motor very neatly packed away at the bottom.

(To be continued.)

ALTERNATE-CURRENT TRANSFORMERS.

BY DR. J. A. FLEMING, F.R.S.

The second Cantor lecture of the series of four by Dr. Fleming on the above subject was delivered on Monday last. After briefly referring to his last lecture, Dr. Fleming showed a most interesting water analogy to explain the action in transformers. Using a U-tube, with limbs of different diameter, half filled with coloured water, he imparted a varying pressure on the water in one limb, causing it to rise and fall. The motion of the water in the other limb then had a corresponding movement, but the height of the waves in each tube was, of course, proportional to the areas of the tubes. Also, the water was at its highest level in one tube when the water in the other was at its lowest. This corresponded to the 180deg. difference of phase between the primary and secondary currents in a transformer. Dr. Fleming then proceeded to discuss the construction and manufacture of transformers. He stated that every transformer had three fundamental organs—*i.e.*, the iron circuit and the primary and secondary copper windings. Dealing with the lamination of the iron circuit, he stated that it had been proved that there was no advantage in using plates thinner than one hundredth of an inch, and also that unless they had plates thinner than 1-25th of an inch it was useless to laminate at all.

He then proceeded to discuss the data connected with hysteresis and eddy currents in the iron cores, and gave the following formulæ. The eddy-current loss, E, per cubic centimetre of iron in watts, where t = the thickness of the iron plates in mils, n = the frequency, and B = the induction in C.G.S. lines per square centimetre, is obtained as follows:

$$E = \frac{(t\,n\,B)^2}{10^8}.$$

Again, E′ the loss in eddy current per pound of iron is given by

$$E' = 1{\cdot}4 \times 10^6 \frac{(t'\,n\,B')^2}{10^8},$$

where t' = thickness of plates in inches,
and B′ = the C.G.S. lines per square inch.

The formulæ for hysteresis loss were as follow:

$$H = \frac{{\cdot}0032\,n\,B^{1{\cdot}55}}{10^7},$$

and

$$H' = \frac{{\cdot}88\,n\,(B')^{1{\cdot}55}}{10^9},$$

where H = hysteresis loss per cubic centimetre;
H′ = ,, ,, ,, pound;
n = the frequency;
B = the induction in C.G.S. lines per square centimetre;
B′ = the induction in C G.S. lines per square inch.

The lecturer, to show the accuracy of these formulæ, gave a list of a series of old Ferranti transformers, comparing the observed and calculated iron losses. The two compared fairly well in some cases, but it was not pointed out that the constant in the hysteresis formulæ had to be varied in order that they might do so, nor was it mentioned at what temperature the eddy-current formulæ were correct.

That such corrections are needed might perhaps be inferred when it was afterwards stated that no iron should be accepted which had a higher loss than ⅓ watt per pound at 100 ∽ and B = 2,500. A curve was then shown on the screen which was stated to give the variation of hysteresis and eddy currents with the thickness of plate. The hysteresis curve showed an increased loss of 100 per cent. over the range of thickness, but the new fact (?) that the hysteresis varies with the thickness of plate was not referred to. The possibility of making a transformer with no iron loss was most interestingly discussed, and then a series of exhibits of commercial transformers ended a most practical lecture.

INSTITUTION OF ELECTRICAL ENGINEERS.

The following gives more fully than it was possible to do in our last issue the concluding speeches in the discussion on the wiring question at the Institution of Electrical Engineers on the evening of January 23.

Mr. W. Langdon, who followed Major-General Webber, said that he was not going to join in any general condemnation of wooden casing It had been of great purpose in extending the use of the electric light. It was cheap, and where it was carefully employed it was still calculated to be of considerable service. Of course, metal tubing was safer than wooden casing, but where buildings were already erected it would be inconvenient and unsightly to wire with tubing. Wood casing was cheap, and there was no law to compel the wiring contractor to use any one particular method, and therefore the cheapest would be employed. The practice, however, of fastening the casing with metal screws or nails between the two grooves carrying the wires was not a good one since, with impaired insulation, these would greatly assist in making a short-circuit between the two wires. Screws at the sides were therefore better. The rule had been adopted by the Midland Railway Company that where wires were out of sight iron tubing should be employed, but wooden casing should be used where it could be easily seen. He had seen samples of wiring work carried out by firms of good reputation where many of the joints were dry joints, and were found to be insulated with nothing better than adhesive tape. If they got that sort of thing when a firm was not carrying out a contract job, what might they expect when they had a contractor doing work inside a fixed price? Mr. Mavor had thrown out the suggestion that the fire insurance offices should combine to employ a competent man in every town to inspect installations, but there were many towns in which it would be difficult to secure the services of such a man and properly paying him. It would, he thought, be better for the supply companies to establish a system of competent inspection of installations while they were in progress, since, though the supply companies had power to reject any installation that was found defective, they had in many cases nothing to go upon but an insulation test and a cursory inspection

Mr. Donovan spoke of the necessity of inculcating a careful attention to detail on all who were engaged in wiring work.

Mr. Antill thought it had been clearly brought out by the two papers and the discussion that no one system was applicable to all cases, and that the contractor must vary his system according to the circumstances. As to open work, the most prominent example of that was at the British Museum, where the wires were supported on porcelain insulators. This had given the most perfect satisfaction since it was first put up. He did not think that Mr. Bathurst had used the word "accessibility" quite fairly in applying it to wires in tubes that could only be inspected by drawing out. No one would be in the least likely to inspect wires by drawing out until after a fault had occurred. He (the speaker) considered that "accessibility" implied that the facility for inspection was such that an incipient fault could readily be discovered. Again, the curve published by Mr. Mavor did not accurately indicate the employment of the wiring men throughout the year. What it indicated was merely the number of lamps connected on to the mains each month in Glasgow. The work of a large installation might be spread over several months, but the result would be all placed to the credit of the month in which it was finished. The practice of insisting on a high-insulation test for cables defeated its own object; for a high-resistance test could be obtained by other means than quality and thickness of the insulating covering. In conclusion, Mr Antill called attention to the similarity of the concentric cable to the concentric leads employed in the single-wiring system which was worked out by Mr. John Raworth for ship-lighting many years ago.

Mr. Campbell Swinton said that experience had shown that Mr. Mavor's system was not at all unsuited for highly-decorated houses. He had been convinced of that by an example of it shown to him at Dumbarton. But there was one practical difficulty in the way of the adoption of the system. It meant that the contractor must maintain two separate staffs of workmen. If a contractor was going to use wood casing his men must be of the house-carpenter class, while if the concentric system were adopted the men wanted would be more like plumbers. The concentric system was at present only applicable to alternating-current systems where there was a separate transformer or to isolated plant installa-

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tions, and was not applicable with continuous-current systems where the supply was taken from the public mains. He had lately had to report on the lighting of a building in Edinburgh, and it was in doubt whether it would be better to take current for the Corporation mains or to have a separate generating plant. If the former course was adopted, the concentric cable system, though eminently adapted to the case, must be ruled out, since the outer conductor could not, under the regulations, be earthed. He had recently made some experiments to see what current could actually be carried by certain wires of small size. Thus a $^{3}/_{22}$ vulcanised wire cased in the ordinary wood covering took a current of 26 amperes for half an hour with a rise of only 107deg. F. The current density worked out at 13,700 amperes per square inch. Again, a $^{3}/_{25}$ wire in the same condition stood a current of 26 amperes for one hour, the rise of temperature being 242deg. F The temperature had in that time become constant. The density in this case was 28 900 amperes per square inch. He had also passed 10 amperes through an ordinary flexible wire without damage. He did not recommend this high current, but gave the facts to show how difficult it was to state what current a wire would safely carry.

Mr. C. S. Corlett said that he was at one time sceptical about the advantages of the system of concentric wiring, partly owing to the difficulty of obtaining workmen skilled in the erection of it. He had, however, recently equipped a large cotton mill with some 600 lights on Mr. Mavor's system, and had found it cheaper than he had expected. The total cost had worked out at 17s. per lamp. As regarded the question of increased voltage raised by Mr. Geipel, he had had an installation at 200 volts working in a colliery and had found the lamps quite satisfactory.

Before adjourning the discussion, **Sir David Salomons** referred to a case in the early days of electric work in which the inspector, after having the term "cut out" explained to him, went away quite contented that the work was in order.

The following letter has been addressed to all members and associates of the Institution of Electrical Engineers:

"The Council of the Institution of Electrical Engineers have resolved 'that steps should be taken to render available for purposes of national defence the technical skill of electrical engineers, and that a committee be appointed with instructions to take such steps as it thinks fit to attain that end,' and have appointed the following gentlemen as members of the committee: The President (Dr. J. Hopkinson, M.A., F.R.S), Sir Frederick Abel, Bart., K.C.B., D.C.L., F.R.S, Mr. R. E. Crompton, and Major-General C. E. Webber, C.B. (past-presidents), Mr H Edmunds, Mr. R. S. Erskine, and Mr. A. E. Mavor, to whom have since been added Sir Benjamin Baker, K.C.M.G., LL.D., F.R.S., and Prof. A. B. W. Kennedy, LL.D., F.R.S.

"It hardly seems necessary to point out in how many ways a practical knowledge of electrical science could be made useful in time of war. Everyone knows that the acquiring of a knowledge of this science is a not unimportant part of the training of military engineers. This knowledge electrical engineers already possess, but they have at present no opportunity in time of peace of preparing for the practical application of that knowledge for the purposes of war.

"In order to carry out their instructions, it is necessary for this committee to ascertain what support it may expect from members of the Institution and others engaged in electrical industries. Hence the present communication and the following questions are addressed to you.

"One of the objects of this committee is to ascertain if there are candidates amongst the electrical engineers to fill the vacancies in the list of officers.

"In order to enable you to judge of the matter it may be well shortly to state the existing conditions of service in the various corps, particularly of military engineers, which now form part of the reserve forces of this country.

"These are divided between militia and volunteers, and are described, with a list of the names of the commissioned officers, in the monthly army list, which also gives the various places where those corps are located.

"With one exception (the corps of railway managers and engineers) they are formed in battalions and companies, having the usual military organisation.

"The volunteer force is composed of the following arms: light horse, artillery, engineers (fortress and submarine mining), rifles, medical staff corps.

"The corps of engineers (submarine mining) is perhaps the arm to which electrical knowledge is most extensively applied at the present time. There exist divisions located on the Clyde, Forth, Mersey, Severn, Tay, Tees, and Tyne. The divisions are in general highly efficient, but there is a lack of officers. The preliminary training of officers requires in all about six weeks' work, which may be spread over two years. The duties of officers include attendance in camp at the headquarters of their division for not less than eight or more than 15 days, and at 48 drills, a full day's work counting as six drills. The advantages are—very interesting and healthful work, and an allowance of 10s. a day employed in training or in camp.

"In the other arms there is much less need for attendance at a camp which may be remote from the home of the volunteer. The corps of fortress engineers is recommended to those who cannot afford time for prolonged attendance at a distance from their residence The following is a list of the existing regiments of fortress engineers: 1st Middlesex, 1st Lanarkshire, Edinburgh City, 1st Lancashire, 1st Newcastle on-Tyne, Yorkshire (West Riding), 1st (Sheffield), 2nd (Leeds), Gloucestershire 1st (Cheltenham), Cheshire 1st (Birkenhead), 2nd (Railway) Crewe. Denbigh, Tower Hamlets 2nd (East London), Cumberland, Surrey, Hampshire 1st (Portsmouth), Glamorgan, Essex, Devonshire and Somerset 1st(Exeter), London 1st (North), Flintshire 1st(Buckley), Northamptonshire 1st (Peterborough), Durham 1st (Jarrow), Aberdeenshire 1st.

"In the case of the militia longer attendance is required in camp than in the case of the volunteers—for example, the militia submarine miners have annually 55 days in camp, and during the first year four months' training. Of this arm there are divisions located at Portsmouth, the Needles, Plymouth, the Thames, the Medway, Harwich, Milford Haven, Western (Severn), the Humber, and Falmouth.

"*Special Corps.*—The modern development of the uses of electricity is certain to lead to its extended application in war time. It is proposed, therefore, subject to the approval of the War Office, to organise and train a special corps of electrical engineers, whose duties will be defined at a later date.

"It will further be the object of the committee to ascertain if the military authorities will regard favourably the enrolment of electrical engineers on some such basis as was followed in the case of the railway engineers, by which the services of many who cannot afford the time for organised training, but who are willing to seek certificates of efficiency suitable to their attainments, can be promptly utilised by the War Office in case of national emergency.

"This statement will, we believe, enable you to judge which branch of the force you could most usefully join. Will you kindly reply to the questions put on the accompanying form? Later, if you are disposed to take an active part in the movement, you may expect to hear from us further.

"If you occupy a leading position, superintending the work of artisans, will you also ascertain and inform the committee how many of these in your employment would be willing to join such a special corps as has been suggested.—On behalf of the committee,

"J. HOPKINSON, President."

The following are the questions put on the accompanying form referred to:

"1. Are you willing as an electrical engineer to register your name as ready to undergo training, and to serve in case of urgent need?

"2 Are you willing to begin training at an early date, and to accept a commission in the reserve forces if obtainable, or to join the ranks of a volunteer corps?

"3. Which branch of the reserve forces do you prefer?

"4 Would you prefer to join a special corps of electrical engineers (*a*) as an officer, (*b*) in the ranks?

"5. Are you at present a member of any volunteer corps?"

THE PHYSICAL SOCIETY.

A meeting of this society was held last Friday evening, Captain Abney, the president, being in the chair.

Mr. Campbell Swinton exhibited some photographs which he had taken by Prof. Röntgen's method. These included several of metal objects inside wooden and cardboard boxes, and a very clear and sharp photograph of the bones of the hand.

Mr. E. Scott showed some geometrical instruments invented by himself and Signor Monticolo. The instrument designed by Signor Monticolo was intended for drawing arcs of circles of such large radius that compasses cannot be employed It can be used to trace arcs of circles of which the radii vary from 50cm to infinity. The second instrument exhibited was a modified form of hatchet planimeter, which Mr. Scott has devised with a view of avoiding some of the defects of the ordinary form of instrument. Thus, to avoid the cutting of the paper, which occurs when the knife-edge is sharp and the side slip, which occurs when the knife-edge is blunt, the author uses a wheel with a sharp edge. To avoid the inclination of the instrument to one side, which may easily occur with the ordinary form, a flat celluloid plate, with a dot at the centre, is used as the "tracing point," this plate being kept pressed flat on the surface of the paper. A small wheel with a recording disc is attached, and may be used to measure the distance between the first and last position of the knife-edge. Mr. Scott also described a form of planimeter which he had invented, and in which the disc and cylinder movement is used to perform the integration.

Mr. C. V. Boys said that an instrument designed by Mr. Clarkson had been exhibited before the Royal Society which was capable of drawing arcs of circles of large radius. This instrument only drew an approximation to a circle, but the approximation was so close that it nowhere was more than the thickness of a thin ink line away from the truth. It would be interesting to hear from the author whether Signor Monticolo's instrument drew a rigorously exact circle or not. The upright position of the hatchet planimeter might be secured by using two wheels in place of one. The planimeter described was really a modified form of one he (Mr. Boys) had described before the society in 1881.

Mr. Blakesley gave a short geometrical proof showing that the curve traced by Signor Monticolo's instrument was rigorously an arc of a circle Mr. Blakesley also drew attention to the fact that the instrument in its present form cannot be used to trace the arc on both sides of the zero line.

Dr. C. V. Burton described an idea for an instrument for drawing circular arcs which had occurred to him, depending on

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the use of two wheels of different radii, connected by an axle carrying a tracing point

In the absen e of the author, Prof. J. D. Everett's paper on "**Resultant Tones**" was read by **Dr. Burton.**

COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY.

The ordinary half-yearly general meeting of this Company was held on Tuesday at Winchester House Old Broad-street, E C., Mr. C. G Mott, the chairman of the Company, presiding.

The **Chairman**, in moving the adoption of the report and accounts, a copy of which appeared in our last issue, said the Company had carried during the half year over 3,000 000 passengers with perfect safety and great punctuality There had, nevertheless, been a decrease of 103,000 in the number of people carried, as compared with the corresponding half of 1894 but an increase compared with the June half of last year of about 60,000. The decrease was explained by the fact that they increased the fares about a year ago in order to diminish overcrowding; it had that effect, but also decreased their receipts. Then, during the first three months of the past half year there was very hot weather, and that always acted prejudicially on the traffic on the line As a result of the decrease, they had reconsidered the question of the fares and had lowered them at one of the stations to their old level. The result was that they immediately obtained an increased number of passengers, and this compensated them for the loss they had in the previous quarter, but left them with a decrease in receipts of £50. On the other hand their season ticket holders had slightly increased, while the receipts from that source had been augmented by £290 Their object in increasing their fares was to lessen the overcrowding in the early morning trains but, unfortunately, as had been seen, this decreased their revenue. They had partially recovered that loss and he hoped in the current half-year they would show a decided increase, both in passengers and receipts. To deal with the overcrowding they had made some alterations at King William-street Station by which they could have two trains in at once, as at Stockwell which obviated the necessity of waiting for trains, and would also allow them to run some additional trains. Hitherto they had unfortunately had to turn away a large number of passengers and to delay those who travelled. This injured their traffic very considerably, because people coming to the City wanted to be certain of arriving at a given time almost to the minute, and if they could not depend upon the electric railway for that they either arranged to travel by other means or even ceased to reside in their district. The directors had now done everything they could with their present line to meet the traffic, and to provide accommodation for it and they hoped these new arrangements would enable them to keep pace as far as possible with the demands upon them for another twelvemonth. It was only, however, a temporary provision, and they felt that the time had now arrived when they could no longer delay the additional accommodation which they proposed to provide to enable them to deal with the rapidly-increasing traffic on their system. They had been very cautious about not going on with this work earlier, but he was afraid they had delayed the matter too long. It was evident that there was no time to be lost now, and they were asking the authority of the shareholders to proceed at once with their extension. In their report they therefore asked for authority to proceed with that portion of the Islington extension lying between its connection with the existing line and Finsbury pavement. After referring to the details of the report and accounts, the Chairman said the net result was that they were better for the half-year by £673, which was nearly equal to an increased dividend of ¼ per cent. They did not, however intend to declare that extra dividend, as the money was wanted to replace the balance brought forward which had been drawn upon last year to make up the dividend. They had not only restored that balance to its old figure, but had improved it. Their working expenses had been 59·2 per cent., as against 60 9 per cent. for the corresponding half-year, or omitting the expense of the lifts 51½ per cent., compared with 52 per cent. in the corresponding period In reference to their extension, satisfactory arrangements had been made as regarded the sites of the stations up to Finsbury-pavement, and they felt pretty certain that the line could be completed for the amount stated last year as the estimated cost—namely, £280 000. It was not possible to fix the amount exactly, but if they did it for that sum they would, considering where it was situated, get a very cheap line. They did not propose at present to proceed with the extension of the line beyond Finsbury-pavement to the Angel at Islington, and as the powers of the Company for the compulsory purchase of lands in connection with the Act of 1893 would expire in August next, application was being made to Parliament for a further extension of that time. In the same Bill powers were sought for the acquisition of a site for a temporary shaft in the Borough High-street, with a view of saving expense in the construction of the junction of the new extension with the existing tunnels.

Mr. Sampson Hanbury seconded the adoption of the report, and it was carried unanimously.

Formal resolutions authorising the payment of a 5 per cent. dividend on the preference, and a 1½ per cent. dividend on the ordinary stock, were passed, and the retiring directors and auditor were re-elected.

Notice having been given for an extraordinary general meeting, the **Chairman** then proposed a resolution authorising the additional capital sanctioned by the Act of 1893 by the creation of 55,000 new ordinary shares of £10 each and 20,000 preference shares of £10 each, bearing 5 per cent. interest. The Chairman said the Board had most carefully considered what was the most economical way of raising money for the extension, and had concluded that it would not be desirable to obtain it by ordinary shares at their present price. The Company's preference shares were selling at 50 per cent. premium, so that by issuing 5 per cent. preference shares they would be obtaining the money at 3½ per cent. They did not intend to interfere with the dividend on the ordinary share capital, and the preference shares would be issued in such a way that the dividend on them would not be payable until the line had been opened and in operation for some time.

Mr Barclay Heward seconded the motion.

Mr Thomas Hanbury strongly opposed the projected extension, and, in the course of a long speech, contended that it was really a new undertaking, and therefore ought to be constructed out of ordinary capital. He strongly doubted whether the extension would realise the expectations of the Board, and was certain that, as regards the traffic from the London Bridge Station, passengers would go over the bridge in an omnibus rather than under it in the Company's train, as there would be no saving of time. The line was called an extension but it was practically the beginning of a new line with a terminus in a new direction. The London, Brighton and South Coast Company were the proper persons to make such a line as was now proposed, but they had made no movement and given the Company no encouragement. Moreover, he did not think the Company ought to incur the odium attached to removing the church of St. Mary Woolnoth. He considered it unwise and unjust to place £10 000 per annum required for the preference dividend in front of £7,500 per annum, the only income at present available for the ordinary shareholders, and he therefore proposed that the issue of £200 000 of 5 per cent preference shares be not authorised

Mr. J T. Middleton seconded the amendment.

Mr. Drake supported the original resolution on the ground that the matter had already been decided, and several questions followed from shareholders as to the terms and time of the new issue.

The **Chairman**, in reply stated that he could not go into the question of the desirability of constructing the extension, as that had been approved by the meeting when the report was passed. The point before them was simply the best mode of raising the money. They had fully considered this matter, and they were convinced that it would be most undesirable in the interests of the Company to obtain the capital by means of a separate undertaking. They were going to make a station for the Brighton and South-Eastern Companies' traffic at London Bridge, and they would have an underground connection up to the platform of the Brighton Company. He had not the least doubt that they would get a very large traffic there. If he had any doubt it would be as to their capacity for dealing with the traffic coming in such masses in the morning As to St Mary Woolnoth, it was only within the last two or three days that any opposition had been expressed to their taking the church. The opposition came from the City Church Preservation Society, and not from the ecclesiastical authorities. The bishop and the incumbent were satisfied, and the money paid for the site would be used for constructing churches in poor and populous districts, where they were more needed. It was, however, too late to discuss this question now, for all their arrangements were completed. The matter had been before the public for three or four years, and they had no objection made until now. There was practically no other site available The matter was discussed before the Parliamentary Committee of the Bill, and it was too late to reopen it.

On the amendment being put only three or four hands were held up for it, and it was accordingly lost, and the original motion carried.

The meeting was then made special for the approval of the Company's Bill in Parliament extending the time for purchasing the land for the purposes of their Act of 1893 and for completing the underground railway and works thereby authorised, and the formal resolution having been carried unanimously, the meeting ended with the usual votes of thanks.

EASTERN TELEGRAPH COMPANY

The forty-seventh half-yearly ordinary general meeting of the Eastern Telegraph Company, Limited, was held at Winchester House on January 23. The **Marquis of Tweeddale** (vice chairman of the board of directors) presided, in the absence of the chairman (Sir John Pender, M.P.) through indisposition, and moved the adoption of the directors' report, with accounts, for the six months ended with September last. The past half-year, he said, was one of the most satisfactory the Company had ever experienced. It was distinguished by two very satisfactory features. One was a large increase in the receipts, and the other was a decrease in the expenses. This was fully borne out by the figures. The revenue for the half-year was £409,779, being an increase of £47,223 compared with the corresponding period of 1894. An examination of the message receipts from various sources showed a satisfactory increase in nearly all classes of traffic, but the principal increase was in the traffic with West Australia and South Africa, which was owing to the activity in the gold mining markets. With respect to the traffic with South Africa, it was satisfactory to note that, notwithstanding the large reductions made in the tariff, an increase had taken place on the value of the traffic

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at the former rates, but, as this was entirely owing to special circumstances, they could hardly count upon its being maintained. The total ordinary expenses for the half-year ended September 30 had been £96,704, or a decrease of £829 compared with those of the corresponding period of the previous year. So long as the Company could show an increase of revenue and at the same time keep down the ordinary expenses within reasonable limits the shareholders would agree that the position would be a very satisfactory one, and this was borne out by the fact he had stated, that, notwithstanding a considerable increase of the revenue for the past half-year, the ordinary expenses showed a substantial decrease; but, although every care was exercised in the control of the working expenses, the shareholders must not be surprised if in the future some increase were incurred As regarded the Company's ships, the greatest economy was exercised consistently with keeping them in the highest state of efficiency, which could not be done without spending a great deal of money. But by this means the Company were able, in the case of breaks or interruptions, to restore the communications in the shortest possible time, thereby saving loss of traffic and maintaining an efficient service for Governments, for the Press, and for the general public. After providing the usual amount for interest on debentures and debenture stock, and the usual two quarterly dividends, they were enabled to carry £10,000 to the maintenance ships' reserve fund and £50,000 to the general reserve fund, and the balance of £49,352 was carried forward to the next half-year. They had applied a further sum of £50,000 from the reserve fund in reduction of the cost of the Aden-Bombay No 3 cable, leaving a balance of £70,000 still to write off, but he was glad to say that the cost of this cable would have been wholly applied to reserve fund when they submitted the accounts to the end of their financial year up to the 31st of March next. The investments on account of their reserve funds amounted on September 30 to £423,000, but their market value showed an appreciation of nearly £60,000. Altogether, the accounts might fairly be considered very satisfactory. Generally speaking, their cables were in good working condition, but they were of all ages and lengths, and the numerous breaks and interruptions warned them that they ought to continue to add to their reserve fund, which, in the opinion of all those whose opinion was worth having, was still very inadequate—in fact, before they could consider it in a satisfactory state it ought to be double its present amount. He thought it right to take that opportunity of informing them of the actual facts with reference to their recent interruption on the East and West Coasts of Africa On the 24th ult. the Aden-Zanzibar cable became interrupted. They had two ships available for its repair—one belonging to the Eastern Company, which had just left Suez, and was on its way to Aden, the other belonging to the Eastern and South African Company, which was stationed at Cape Town. The latter company found that by hiring the Eastern Company's ship a saving of about a week in restoring the cable would be effected, and orders were immediately given for the Eastern Company's vessel to proceed to the spot. She hooked the Aden end at the second sweep, and communication was restored *vid* the East Coast on the evening of the 4th inst Meanwhile events had happened in the Transvaal of which they were all well aware, and their West Coast route had been called upon to carry not only the whole of the ordinary traffic, but also an enormous amount of additional traffic. Until the morning of the 30th ult the West Coast line was able to keep up to the work, but on the news that Dr. Jameson had crossed the Transvaal frontier, the line was occupied almost entirely by telegrams sent by and to European Governments. It might not be generally known that Governments had the right, under the International Telegraph Convention, of priority of transmission for all their messages, and this particular traffic was forwarded without exceptional delay. Immediately the East Coast route was restored the delay began to diminish, and on the 10th inst. they had completely recovered their normal working, which was owing not only to their having two lines available, but also to the cessation of the special Government traffic. It had been a time of great anxiety for the Company. They had desired above everything to be absolutely fair, and to treat the whole of their traffic in accordance with telegraph law, and he could not help saying that he thought they had succeeded. At any rate not a single complaint, as far as he was aware, had come from our own Government; on the contrary, he had reason to think that it was highly satisfied at the way its business was done Nor had they received any complaint from any other Government, foreign or otherwise, who had important interests in connection with South Africa.

Lord Sackville A. Cecil seconded the motion.

In the discussion which followed, **Mr. Baines, Captain Godsall,** and **Mr. Wood** advocated the payment of a higher dividend than 6½ per cent. in view of the satisfactory position which had been reached by the Company.

Mr. John Newton regarded the dividend as a very satisfactory one. The payment of very high dividends would simply attract competition.

The **Chairman,** in reply, stated that the directors would give their best consideration to the suggestions which had been made relative to the dividend, and if they could see their way to increase it at the end of their financial year without interfering with the policy they had hitherto pursued they would be happy to do so He, however, reminded them that if a cable or cables were laid across the Pacific the Company's traffic would be considerably affected.

The motion was unanimously adopted.

CAMBRIDGE ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: D. Munsey, Esq., chairman; the Hon. C. A. Parsons, managing director; Sir B C. Browne, D.C.L.; Wm. C. Hall, Esq.; P. W. Latham Esq., M.D.; John B. Simpson, Esq. John H. Barker, general manager and secretary.

Report of the directors to be presented to the shareholders at the fourth annual general meeting to be held at the offices of the Company at Cambridge to-day at 12 noon:

Your directors have pleasure in reporting that the prospects of the Company continue to be satisfactory During the year 1895 there has been added to the Company's mains the equivalent of 3,016 8-c.p. lamps - making the total 14,660. A new bay has been added to the boiler-shed, with an additional boiler to meet the increased demand. Owing to the flood in November, 1894, the Company had to deepen their main intercepting wells to provide a constant supply of water; this was successfully carried out during the summer months. A new 75-unit dynamo and engine has just been added to the plant, bringing up the total capacity of the station to 522 units; this machine began work on January 11 of the present year A length of 903 yards of main conduit pipe has been added—making a total of 13,051 yards—whilst another sub-station fully equipped, has been constructed to supply Trinity College, Trinity-street, Bridge-street, and Sidney-street. At the end of the year one-third of the total supply was delivered from the sub-stations, resulting in a marked economy in fuel The number of units supplied during the year has been 150 510 against 112,084, an increase of 38,426, or 35 per cent. The Company has made a profit on the year's working of £1,489 8s. 10d., which added to £19 18s 2d. brought forward from last year, leaves £1.509. 7s and after paying £48. 11s. 11d. interest on debenture capital there remains a balance of £1,460 15s. 1d. Your directors therefore advise the payment of a dividend of 3½ per cent., absorbing £1,126. 17s. 11d., leaving £333 17s 2d. for depreciation and carrying forward During January, 1896, lamps equivalent to 860 8 c.p. have been connected in the new theatre Mr. Wm C Hall and Mr. J. B. Simpson retire by rotation; both are eligible and offer themselves for re-election. The auditor, Mr. Arthur Rutter, also offers himself for re election.

Dr. BALANCE-SHEET, DEC. 31, 1895.	£	s.	d.	£	s.	d.
Capital—5,000 shares at £10 each				50,000	0	0
4 077 shares issued, £8 called up				32 616	0	0
Debentures, £3 500 at 4 per cent.				3,500	0	0
Creditors	£1,477	19	1			
Bankers	13	13	5			
				1,491	12	6
Profit and loss account - profit for year ending December 31, 1895, as per statement	1,440	16	11			
Balance from last year after paying dividend and income tax	19	18	2			
				1,460	15	1
				£39 068	7	7

Cr.	£	s.	d.
Amount expended to date on land, buildings, plant, pipes, cables, meters, transformers, electrical instruments, public lamps, etc	34,435	8	7
Less depreciation fund	100	0	0
	34,335	8	7
Provisional order	1,005	0	0
Preliminary expenses	1,584	3	9
Stock of stores, etc.	29	19	0
Sundry debtors	2,105	0	2
Cash in hand	8	16	1
	£39,068	7	7

PROFIT AND LOSS ACCOUNT FOR YEAR ENDING DEC. 31, 1895.

Dr.	£	s.	d.
Wages, salaries, rents, rates, and taxes	1,022	19	0
Stores fuel and water	1,360	2	3
Repairs and renewals	384	9	0
Stationery and general expenses	78	18	0
Balance carried down	1,489	8	10
	£4,335	17	1
Interest on debentures and loans	48	11	11
Balance carried to balance-sheet	1,440	16	11
	£1,489	8	10

Cr.	£	s.	d.
Electric energy supplied less discounts	£4,106	6	6
Meter rents	229	10	7
	£4,335	17	1
Balance brought down	£1,489	8	10

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

Directors: Eustace J. A. Balfour, Esq. (chairman); Latimer Clark, Esq., F.R.S. (vice chairman); Sir John H. Morris, K.C.S.I.; Bennett Fitch, Esq., M.I.C.E; Walter Leaf, Esq. General manager and secretary: Frederic J. Walker. Chief engineer S. T. Dobson, A.M.I.C.E., M.I.E.E.

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Report of the directors and abstract of accounts to be presented to the shareholders at the annual general meeting to be held at the offices of the Company, Carnaby-street, Golden-square, W., on Tuesday, February 4, at 12 30 p.m:

The directors in submitting their report for the year 1895, with accounts as certified by the Company's auditors, are pleased to state that the business shows a steady increase, and that the position of the Company has been considerably strengthened during the past year. The building extension in Carnaby-street has been completed and the station equipped with its full plant, and the working of this and of the supply generally has proved most satisfactory. The actions instituted by the Attorney-General on behalf of the parish and by the Windham Club, alleging nuisance from the plant at Mason's yard station, have been arranged. The directors have disposed of the greater portion of the engine plant at Mason's-yard station, and are replacing it by machinery of a similar description to that in use at the Carnaby-street station, and it is believed that the alterations have had the effect of putting an end to the annoyance complained of. The exceptional expenses incurred in the actions and by the consequent change of machinery have been charged to revenue. Certain negotiations have been in progress between the directors and holders of founders' shares with a view to the consolidation of interests, but no definite arrangement has been arrived at. In the month of November, in accordance with the intimation given in the report of last year, a further issue of £20,000 debenture stock was made to the shareholders at 2½ per cent. premium, making a total of £50 000 already issued. The net earnings of the Company during the past year have amounted to £14 580. 7s. 9d. Of this sum £5,498 was distributed in July last in payment of an interim dividend at the rate of 4 per cent. per annum for the half-year ending June 30, 1895, on the ordinary shares, and of 7 per cent. per annum on the preference shares. The balance, £9,082. 7s. 9d., together with the undivided profit of £95. 3s. 7d. from last year's account, leaves £9,177 11s. 4d. now to be dealt with. The directors propose to divide this amount as follows:

(*a*) By payment of a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year	£3,500	0	0
(*b*) By payment of a dividend at the rate of 10½ per cent. per annum for the second half-year on the ordinary shares, making, with the interim dividend paid in July last, a total distribution of 7½ per cent. for the year	5,244	15	0
(*c*) By paying a dividend of £2 19s. 6d. per share on the founders' shares	297	10	0
(*d*) Amount to be carried forward to ordinary shareholders' undivided profit account	134	13	3
(*e*) Amount to be carried forward to founders' undivided profit account	0	13	1
	£9,177	11	4

Having been appointed Chief Secretary for Ireland, the Right Hon. Gerald W. Balfour, M.P., resigned his seat on the Board to the regret of his colleagues. Mr. Walter Leaf has been elected a director during the year, and in accordance with the articles of association he now retires, but, being eligible, offers himself for re-election. Mr. Bennett Fitch, M.I.C.E., is the director who retires by rotation under Clause 79 of the articles of association, and, being eligible, offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and, being eligible, offer themselves for re-election.

REVENUE ACCOUNT YEAR ENDING DEC. 31, 1895.

Dr.	£	s.	d.	£	s.	d.
A.—To Generation and Distribution of Electricity.						
Coal, including dues, carriage, etc.	£4,545	10	7			
Oil, waste, water, engine-room stores	728	6	9			
Salaries of engineers and officers	1,356	17	9			
Wages at generating and distributing stations	3,153	10	3			
Repairs and maintenance, as follow: buildings, £133. 8s 10d.; engines and boilers, £722. 17s. 11d.; dynamos, £466. 8s. 4d; other machinery, instruments, and tools, £111. 9s. 3d.; accumulators, £82. 1s.; lamps (at stations), £11. 0s. 7d.	1,527	5	11			
Repairs and maintenance of mains.	1,322	12	2			
Miscellaneous expenses	66	14	2			
	12 700	17	7			
Removal and rearrangement of plant	148	16	10			
				12,849	14	5
B.—To Rents, Rates, and Taxes.						
Rents payable	123	15	0			
Rates and taxes	2,397	1	7			
				2 520	16	7
C.—To Management Expenses.						
Directors' remuneration	1,620	0	10			
Salaries of manager and secretary, engineer, clerks, canvasser, etc.	2,465	1	1			
Stationery, printing, and advertising	210	4	0			
General establishment charges	284	2	1			
Auditors of company	78	15	0			
Trustee for debenture stockholders.	52	10	0			
				4,710	13	0
D.—To Law Expenses.						
Law expenses				1,158	1	9
E—To Special Charges.						
Insurance	277	9	1			
Expenses (other than law charges) in abating nuisances	192	10	6			
Fees for testing meters	9	12	0			
Board of Trade audit	52	15	6			
Expenses, *re* rating assessment	31	10	9			
				563	17	10
F—To Depreciation						
Depreciation on buildings	362	1	6			
Ditto plant, machinery, etc.	3,580	13	3			
				3,942	14	9
				25,745	18	4
Net loss on sales of old plant				2 119	4	6
Balance carried to net revenue account				15,487	14	11
				£43,352	17	9

Cr.	£	s.	d.
Sale of current, after deducting provision for bad and doubtful debts	40,670	13	2
Ditto under contract	912	14	4
Rental of meters on consumers' premises	1,076	14	1
Rents receivable, less repairs to houses	525	18	5
Transfer fees	38	12	6
Discounts on purchases	75	9	0
Sale of old materials, stores, etc.	20	2	3
Sundry fees, shareholders' lists sold, etc.	2	14	0
Rent of machinery let on hire	30	0	0
	£43,352	17	9

Dr. GENERAL BALANCE SHEET, DEC. 31, 1895	£	s.	d.
Capital account—amount received	250,000	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel stores, etc.	1,345	19	10
Sundry creditors on open accounts	1,392	18	3
Debenture stockholders, for interest accrued, less tax, payable January 1, 1896	668	17	8
Unclaimed dividends	17	2	8
Capital reserve fund	15,000	0	0
Net revenue account—balance and credit thereof, £14,675. 11s 4d.; less interim dividends paid on preference and ordinary shares, £5,498	9,177	11	4
	£277,602	9	9

Cr.	£	s.	d.
Capital account—amount expended for works, less depreciation to date	237,897	1	9
Stores on hand—coal, £159 12s.; lamps, £33. 19s. 2d.; meters and switches, £635; general, including oil, waste, etc., £1,158. 9s. 8d.	1,987	0	10
Sundry debtors for current supplied, £12 135. 19s. 4d.; other debtors, £817. 16s. 8d.	12,953	16	0
Bill receivable	233	6	8
Cash at bankers (Lloyd's Bank, Limited) including deposit of £8 000, £9,462. 4s. 4d.; cash in hand, £69. 0s. 2d.	9,531	4	6
Capital reserve fund investments, cost of Canada 3 per cent, Cape 3½ per cent., and India 3 per cent. stock	15 000	0	0
	£277 602	9	9

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY, LIMITED.

Directors: Grosvenor Talbot, Southfield, Burley, Leeds (chairman); George Henry Crowther, civil engineer, Huddersfield; Robert William Eddison (John Fowler and Co., Leeds, Limited), engineer, Leeds; R. Hudson, engineer, Gildersome Foundry, near Leeds; Samuel Ingham (Illingworth, Ingham, and Co.), timber merchant, Leeds; Arthur Greenhow Lupton (William Lupton and Co), cloth manufacturer, Leeds; John Thomas Pearson, The Hall, Melmerby, S.O., Yorkshire. Consulting electrical engineer: Robert Hammond, M.I.E E, Ormond House, Great Trinity-lane, London, E C. Secretary: W. T Green.

Report of the directors to be presented to the ordinary general meeting of the Company to be held at the offices of the Company, Whitehall road, Leeds, on February 4, 1896, at 2 30 p.m:

The directors submit herewith a statement of the income and expenditure for the past year, and the balance-sheet showing the assets and liabilities of the Company made up to December 31 last. The profit for the year (including £162. 1s 9d brought forward from the previous year) amounts to £6,483 3s 11d., which the directors propose shall be appropriated as follows: Reserve (for general purpose), £2,000; reserve (for depreciation), £1,300; payment of interim dividend at the rate of 4 per centum per annum upon the ordinary shares of the Company, numbered 101 to 10.100 inclusive, made for the half-year ending June 30, 1895, £1,000; payment of final dividend at the rate of 6 per centum per annum on the same shares for the half-year ending December 31, 1895, making 5 per cent. for the year, £1,500; payment of a dividend at the rate of 5 per centum per annum on shares numbered 10,101 to 18,948 inclusive on the amount called and paid up thereon from the respective times of payment, up to December 31, 1895, £165. 7s. 7d; balance to carry forward to next account, £517. 16s. 4d; total. £6,483. 3s. 11d. The works and plant of the Company have been maintained in an efficient state, and the quality of the supply of electrical energy continues

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to give satisfaction. The number of lamps connected to the mains increased during the year from the equivalent of 19,858 to the equivalent of 32,539 35-watt lamps. A reduced scale of charges for current at a maximum price of 6d. per Board of Trade unit was brought into operation on July 1 last. The Leeds Corporation, in the last session of Parliament, introduced a Bill authorising them to construct and work electric or other tramways, which affected the Company's interests, and the directors obtained the insertion of a clause in the Bill by which the rights of the Company are protected. The Company's mains have been extended to Chapeltown, which has resulted in an encouraging demand for current. It having become apparent that the plant in operation will not suffice to meet the requirements of current that may be expected to arise not later than the winter of 1896, the directors have decided upon an important extension of the Company's works, and arrangements are being made to carry out that object. In order to obtain the necessary capital the remainder of the authorised capital, consisting of 9,900 ordinary shares was offered to the existing ordinary shareholders *pro rata* to their previous holdings, of which 8,848 shares were taken up. The retiring directors, Mr. Grosvenor Talbot and Mr. Robert Hudson, being eligible, offer themselves for re-election. Mr. John Gordon, jun., offers himself for re-election as auditor.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1895.

Dr.	£	s	d.
Coal, including carriage, etc.	670	4	2
Oil, waste, water, and engine-room stores	352	2	0
Salaries and wages of engineers and workmen	1,767	5	0
Repairs and maintenance	416	17	11
Rates and taxes	195	13	3
Directors' remuneration	500	0	0
Salaries of secretary and clerks, stationery and printing, law expenses, and general charges	706	3	0
Insurances	43	8	9
Total expenditure	4,651	14	1
Balance carried to net revenue account	6,780	2	5
	£11 431	16	6

Cr.	£	s.	d.
Sale of current, rental of meters and other apparatus, etc., after providing for discounts	11,273	17	1
Rents receivable	123	3	1
Transfer fees	3	7	6
Students' instruction	31	8	10
	£11,431	16	6

GENERAL BALANCE-SHEET.

Dr. Capital and Liabilities	£	s.	d.
Capital account—Amount received as per last account	56,504	17	10
Received during the year	19,515	2	2
Total amount received	76,020	0	0
Sundry creditors	3,545	2	9
Net revenue account—Balance brought forward from last year £162 1 9			
Profit for the year 6,321 2 2			
6 483 3 11			
Less interim dividend paid July 9, 1895 1,000 0 0			
	5,483	3	11
Reserve allotted out of profits for the year ended December 31, 1894	500	0	0
	£85,548	6	8

Cr. Property and Assets.	£	s.	d.
Capital account—Amount expended for works as per last account	64,118	7	9
Expended during the year	12,408	9	0
Total capital expenditure	76,526	16	9
Stores on hand—coal, £17 4s.; oils, waste, etc., £43. 11s 10d; general, £167. 14s 3d.	228	10	1
Sundry debtors for amounts paid on account of contracts in course of completion	269	2	6
Sundry debtors for current supplied, £5 138 11s. 8d.; less reserved for discounts etc., £300	4,838	11	8
Other debtors	88	0	0
Deposit with Leeds Corporation and interest	1 010	0	0
Cash at bankers	2,573	12	2
Cash in hand	13	13	6
	£85,548	6	8

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Parma (Italy).—The municipal authorities of the city of Parma desire tenders by February 25 for the electric lighting of the city from June, 1897, to 1912.

Teneriffe (Canary Islands).—Tenders are invited for the electric lighting of the town of Santa Cruz, Teneriffe, for a period of 35 years. Particulars can be obtained at the Ministerio de la Gobernacion, Madrid, and tenders must be delivered by February 29.

Paris.—Tenders are asked for the supply of 500,000 kilogrammes of galvanised wire and various telegraphic supplies for the State telegraphs. Application for permission to tender must be made by February 3 to La Direction Générale des Postes et Télégraphes, Rue de Grenelle 3, where particulars may be obtained.

Brunn (Austria).—The Municipality desire offers for the construction and working of a central station for the supply of electric energy for lighting the town, for power, and, if required, for running a tramway. Tenders must be sent before March 31 to the Bürgermeister, Brünn, Austria, from whom particulars can be obtained.

Indian Railways.—The Great Indian Peninsular Railway Company are prepared to receive tenders for the supply of various stores, including telegraph materials and iron telegraph wire. Tenders must be delivered not later than 11 o'clock a.m. on February 6, at the Company's Offices, Copthall House, 48, Copthall-avenue, E.C.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grangetown, Yorkshire, to whom the plans, etc., must be sent by May 1.

Huddersfield.—The Electric Lighting Committee of the Corporation invite tenders for the supply of two steam-boilers, four mechanical stokers and one surface condenser, with air and circulating pumps. Specifications and forms of tender may be obtained of Mr. A B Mountain, borough electrical engineer, St. Andrew's-road, Huddersfield. Tenders, endorsed "Tender for Electrical Machinery," must be delivered to the town clerk, Town Hall, Huddersfield, by February 4.

RESULTS OF TENDERS.

Chelsea (London).—The following were the tenders for proposed electric lighting buildings (boiler-house and engine-room), at Pitfield-street, for the Chelsea Vestry:

Nightingale, Albert-embankment	£10,494	0	0
Pattinson and Sons, Whitehall	8,854	0	0
Manlove, Alliott, and Co., Limited, Nottingham	10 540	16	0
Shelbourne and Co., Fenchurch-street	10 005	5	9
Atherton and Dolman, Poplar	8 535	0	0
Kirk and Randall, Woolwich	9,442	0	0
Jarvis and Sons, Hackney-road	9,926	0	0
Chessum and Sons, Haggerston	9,499	0	0
Wilkinson Bros, Finsbury Park	9,971	0	0
Coulsell Bros., Bethnal Green	9,383	0	0

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—The traffic receipts for week ended January 24 were £2,804.

Stourport.—A resolution has been passed by a meeting of ratepayers giving power to oppose the Electric Tramway Bill if necessary.

Glasgow.—A committee of the Corporation has been appointed to visit Edinburgh for the purpose of inspecting the system of electric lighting there.

Portsea.—The Guardians have decided that the hospital and imbecile blocks shall be lighted by electricity at an estimated cost of £250 for the fittings.

Wrexham.—The Town Council have resolved that it is not desirable to grant any further extension of time to the Wrexham Electric Light Company.

Newcastle.—The poll of the ratepayers will be taken on February 20 as to whether the Corporation shall proceed in Parliament with the Tramways Bill or not.

Belfast.—The Belfast Corporation have appointed a deputation to visit Hamburg and other Continental cities and towns where the electric motor for tramways is in full swing.

Price-List.—We have received from Messrs. Beauland, Perkin, and Co., electrical engineers, of Leeds, a tabulated price-list of their "B. P. C" dynamos and motors, with illustrations.

City of London Electric Lighting Company, Limited.—The gross revenue for the quarter ended December 31 was £44,614, as compared with £29,637 for the corresponding period of 1894.

Dundee.—Some inconvenience was caused by a temporary failure of the electric light supply last week, owing to a breakdown in the boiler pumps and injectors at the central station.

Eastern and South African Telegraph Company, Limited.—The payment by warrants on February 1 of interest for the half-year ending January 31 on the 4 per cent. mortgage debentures is notified.

Linlithgow.—A committee of the inhabitants of Fauldhouse has been appointed to enquire into the probable cost of introducing electric light to supplant the present system of lighting the streets with oil lamps.

Richmond.—The new Free church which has just been built is to be fitted with the electric light throughout, and the work has been placed in the hands of Mr. C A. Hemingway, 10, Petersham-road.

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New Swindon.—The Urban Council have instructed their clerk to obtain information from the authorities which have recently adopted the electric light

Eastern Telegraph Company, Limited.—The call upon the 5 per cent debentures due February 1 will be paid on and after that date at the banking-house of Messrs. Glyn, Mills, Currie and Co., 67, Lombard-street E C

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending January 26 amounted to £1,043 as compared with £943 in the corresponding week of the previous year being an increase of £100

Telegraph Extension in Africa.—A telegram from Matadi announces that the telegraph line of the Congo reached the Nkenge a few weeks ago, and that the work is being actively carried on in the direction of Lufu.

St. James's and Pall Mall Electric Light Company, Limited — The share transfer-books of this Company will be closed to February 10, preparatory to the payment of dividends for the half-year ended December 31, 1895.

Edinburgh — The Lord Provost's Committee of the Town Council have disapproved of the proposal by the National Telephone Company that the Corporation should lay underground tubes for telephone wires at the company's expense.

Llandrindod Wells.—The Urban District Council have resolved to accept a proposal for street-lighting by electricity for the next seven years at an annual charge per lamp of 58s. 6d. (including cost of renewals and repairs) for 70 lamps of 32 c p. each.

An Electric Railway for Brussels —A monorail electric railway, four miles long, is to be built to Tervueren in connection with the Brussels Exhibition of 1897. The curves will be 600 yards long, and each carriage will accommodate 110 passengers.

Cardiff —In the half-yearly estimates of the Lighting Committee the borough engineer has put down on the credit side a profit of £848 on electric lighting, a sum which will very nearly repay the principal and interest to be paid during the six months.

Cuba Submarine Telegraph Company.—The Board of the Cuba Submarine Telegraph Company, Limited, have resolved, after providing for the dividend on the preference shares, to recommend a distribution on the ordinary shares at the rate of 8 per cent. per annum

Portsmouth.—The Electric Lighting Committee have decided to recommend the Town Council to light Goldsmith's-avenue with electricity. The length of Goldsmith's avenue being 1,700 yards, the cost of laying the electric cable and putting up the lamps is estimated at £1 500

Venezuela Telephone and Electrical Appliances Company, Limited.—Coupon No. 11 of the 5 per cent. first mortgage debentures, due January 31, will be paid from that date at the Consolidated Bank, Threadneedle street, E C, or at Messrs. Westendorp and Co.'s Bank Amsterdam

Electricity in Mining.—The Pesterena United Gold Mining Company have laid down an electrical plant, and it is reported that, excepting a few minor items, the installation is practically completed to the 55-fathom level, and will be ready for starting towards the end of the first week in February.

Brechin.—The installation at the paper mill has been carried out by Messrs. Lowden Bros., Dundee. There are 110 of the newest type of incandescent lamps, and an engine from Messrs. Shanks Arbroath, of 8 h p, has been erected to drive the dynamo, which was supplied by Messrs. Mather and Platt, Manchester.

Coolgardie (West Australia).—Messrs. Addenbrooke and Scott, of London and Wolverhampton, have just shipped the first lot of plant, buildings, etc., for the public and private lighting and power of this town. They are doing it on what may be called the new system—viz., 220 volt lamps and simple three-wire distribution with accumulators.

City and South London Railway.—The returns for the week ended January 26 were £994, compared with £998 for the corresponding period of last year, being a decrease of £4 The total receipts for the half-year terminating as above were £4,035, compared with £3,999 in the same period of the preceding year, being an increase of £36.

England and America.—The *Financial Times* is responsible for the statement that since the unfortunate Cleveland message "an important American electrical concern, which was developing a large business in this country, has been practically paralysed for the time being." Our contemporary says that 20 of the engineers and assistants have gone back to their own country.

Daimler Motor Company, Limited.—This Company has been registered by J B. Purchase, 11, Queen Victoria-street, E.C, with a capital of £100,000 in £10 shares. The Company take powers to deal in patents, etc., relating to motors of all kinds, and among other matters to trade as electricians, mechanical engineers, rubber manufacturers, galvanisers, electroplaters, etc.

Company Amalgamation — Messrs. Swinburne and Co., Limited, announce that they have arranged to amalgamate their business with that of the Nalder and Harrison Construction Syndicate, Limited, the works being for the future combined under one roof at Bow Common-lane, E Mr. Holt, late general manager of Swinburne and Co, will join the Board of the amalgamated companies.

Electric Traction on the Underground Railway.—Sir Edward Watkin has announced that the directors of the Metropolitan Company had always wished to substitute electricity for the steam traction now in use but hitherto there had been no scheme whereby heavy trains could be moved by electric power, except at greatly increased cost. Arrangements, however, had now been made which might soon overcome all difficulties

Pembroke Dock.—At a special meeting of the Town Council, Mr. Ford (Carew) and Mr. Baker, electrician, of Llanelly, were introduced to the meeting, and had an interview relative to the suggested lighting of the town by electricity, after which it was decided that Mr H A. Jones Lloyd, chairman of the Gas Committee, should confer with Mr. Baker upon the details of the matter. The result of their conference will be made known to the Council at their next meeting

International Exhibition of Motor Carriages —An arrangement has been completed between Sir Somers Vine, on behalf of the Imperial Institute, and Mr. Harry J. Lawson, director of the Daimler Motor Company, for the great international exhibition of motor carriages which the Prince of Wales has consented to open at the Imperial Institute in May. This exhibition will remain open until August. Its main object is to give an impetus and public interest to the industry of motor carriage manufacture.

Bradford.—The Gas and Electricity Supply Committee of the Town Council have appointed Mr. Thomas Parker to draw up plans for the proposed extension of the electricity works of the Corporation. The members of the Tramways, Baths, and Team Labour Committee have visited Leeds for the purpose of inspecting a new system of electric tramway traction invented by Mr. Christopher Anderson, of Leeds, of which the characteristic feature is the substitution of a closed conduit for the ordinary slot conduit.

Pembroke —A public meeting of ratepayers is to be convened to protest against the Corporation entering into any agreement with a syndicate which is in course of formation for the purpose of lighting the streets of Pembroke by electricity. The syndicate is understood to consist of local men, some of whom are members of the Corporation, and they expect to realise a profit of at least 25 per cent. The opponents of the proposal will advocate the desirability of the Corporation taking the lighting of the streets into their own hands.

Tunbridge Wells.—Mr. H. L. P. Root, the borough electrical engineer, reports that for the first quarter's working 25,323 units were sold to consumers at 6d. per unit, and the cost of generation was 2·9d per unit. The total number of lamps connected and applied for are about 6 000, and new applications are steadily coming in; the past quarter thus shows a net profit of several hundred pounds over working expenses. The probable annual revenue may be put at between £1,500 and £2,000. Interest on capital and sinking fund will represent a charge of 6 per cent.

Kingston-on-Thames —At a meeting of the Town Council the Lighting and Market Committee reported that Mr. Russell, representing Messrs. Siemens Bros., had informed them that the arc lighting mains had been tested, and the company were prepared to relay such lengths where the insulation was found, when tested, to be below a certain point. Messrs. Siemens Bros. had offered to lay at their own expense a new and improved arc light cable upon the Corporation opening and filling the necessary trench. The offer was accepted, subject to the same being guaranteed for three years

Anglo-American Telegraph Company —The directors of the Anglo American Telegraph Company, Limited, after placing £12,000 to the credit of the renewal fund, recommend a balance dividend of 18s. per cent. upon the ordinary consolidated stock, and of £1 16s. per cent. upon the preferred stock, for the year ended December 31, 1895 both payable on February 8 next, less income tax, leaving about £794 to be carried forward. The above dividends, together with those already paid, will amount to £2 9s. per cent. on the ordinary consolidated stock and £4 18s. per cent. on the preferred stock for the year 1895.

Swansea.—Colonel Walter Mender Ducat, R.E., inspector under the Local Government Board, has held an enquiry into the proposal of the Corporation to borrow £60,000 for the purposes of electric lighting and the erection of a dust destructor. Mr. S. T. Evans, M P, who represented the Corporation of Swansea, stated that the system would be the high-tension transformer scheme, which had proved a success elsewhere, and the Corporation would be able to cheaply destroy their refuse and at the same time supply heat for the purposes of the electricity part of the scheme. It is stated that the poll of the burgesses and property owners on the triple electric scheme will take place about February 21, and it is likely that before this Mr. Preece's report will be made known.

Southampton.—At a meeting of the Harbour Board a letter was read from Mr. J. T. Hamilton, secretary to the Southampton Electric Light and Power Company, Limited, stating that at a meeting of his directors the intention of the Harbour Board to lay down plant for the generation of the electric current required in connection with the crane work and lighting of the quay and pier was considered, and, as they were anxious not to lose the Harbour Board as a customer, after having specially laid down plant to meet the Harbour Board requirements, they were willing from the 1st inst. to reduce the charge for power to 4½d. per unit, and at the close of the present agreement with the company to reduce the price both for power and lighting to a uniform charge of 4½d. Alderman Bone gave notice that he would move the rescinding of the Board's previous resolution on the subject, as they decided some months ago to lay down plant to supply their own electricity.

Calne.—The Urban District Council are considering the question of providing the town hall and parts of the town with electric light. Mr. H. E Hall, of Tonbridge, has reported that from the observations of Mr Maundrell on the flow of the stream it might be safely assumed that, with an efficient turbine, about 15 effective horse-power might be obtained from the present water supply.

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For the efficient lighting of the town hall, offices, etc., about 60 or 65 incandescent lamps of 16 c.p. each would be required, and the power to maintain these, if all lighted at once and at one time, would be 6·5 h.p The power at disposal would also maintain eight arc lamps each from 1,500 c.p. to 2,000 c p. The cost of electric plant, including dynamo of best make and of sufficient size, with a proper switchboard and appliances, the wire for the town hall standards and plant for the arc lamps, would be about £475. The total cost of the turbine would be about £200. The matter has been referred to the committee.

Telephones in Yorkshire.—In his reply to the petition from the West Riding for further telephonic facilities, the Postmaster-General intimates that he is prepared, after enquiry as to cost, to recommend to the Treasury the provision of additional trunk wires in the Riding, and further states that the list which had been forwarded to him went beyond that area, and included wires to Liverpool, Manchester, Morecambe, Newcastle, Nottingham, Birmingham, etc. Some of the larger requirements would be met by the backbone system of trunk wires the construction of which had for some time been in hand, and it was thought it would be desirable to await the completion of that system, and to see how, in conjunction with the wires to be transferred from the company, it met the requirements of the public. The Postmaster-General holds out no hope of the time for conversation on trunk wires being extended from three minutes to five. He states that the limit has been adopted by the International Telegraphs Union, and experience has shown that it is ample.

Edinburgh.—The Electric Lighting Committee have under consideration the contemplated extension of the system in the city, and authority was given for the acceptance of offers for boilers, superheaters mechanical stokers, steam dynamos, and other appliances, at a total estimated cost of over £20,000 Instructions were given that in the meantime the extension from the Literary Institute southward to Salisbury-place, and that along Fountainbridge westward from Freer-street to Viewforth, together with the erection of lamps on the Dean Bridge, be proceeded with. It was resolved to recommend the Magistrates and Council to oppose the petition to the Privy Council by Dr. Hopkinson and the Westinghouse Company, praying that the "patent three-wire system," which expires in July next, should be extended for a further term of years. It is understood that the Edinburgh Corporation have never admitted any infringement of the patent on their part. It was decided to advertise for a resident electrical engineer in succession to Mr. Monkhouse, offering a salary of £400 per annum.

Sheffield —A special meeting of the Council has been held to consider the tramways question. The Sheffield District and Rotherham Tramways Company had applied to the Council for their assent to a Bill in Parliament, and the matter has occasioned much discussion and several meetings. The Parliamentary Committee reported that in view of the growing feeling in favour of tramways being acquired and worked by municipal corporations they could not recommend the City Council to give their consent to the Bill. They also recommended that a deputation be appointed, and that the Association of Municipal Corporations and other municipalities be invited to send representatives to wait upon the Presidents of the Local Government Board and the Board of Trade, with a view to endeavour to obtain their support for the suspension of the Standing Orders of Parliament which prevent municipal corporations and other local authorities from working tramways, and that the Right Hon. A. J. Mundella and the Right Hon. C. B S. Wortley be invited to attend with the deputation. These recommendations have now been adopted.

Cardiff.—The Corporation Lighting Committee have again met to consider the statements of the four fitters—Johns, Melhuish F. A. Parker, and Knight—as to certain defects in the engines and boilers at the electrical lighting station in which they are employed, defects which they allege are sufficiently serious to afford ground for anxiety. Alderman P. W. Carey presided, and the investigation lasted for a couple of hours. Mr. Appleby, manager of the works, was present during the first part of the meeting. The Chairman said they would remember that at the last meeting the four men were invited to send in a written report. They had done so, and the report was before him. (The document was bulky and voluminous.) Mr. Morgan Morgan proposed that an expert mechanical engineer report to the committee upon the state of the engines and boilers, and also on the allegations contained in the letters of the four fitters, so far as they referred to such engines and boilers. Mr. W. Evans seconded, and it was carried. and Mr. J. H. Hallett (Cardiff Docks), consulting assessor for the Board of Trade, was unanimously appointed as the expert.

Newcastle-on-Tyne.—A meeting of ratepayers has been held to consider the tramway question. Councillor Gillespie pointed out that they had yet to learn that the electric system at Bristol worked out well financially. Whatever the result of the poll, he trusted the lease would be given to those men who could show by the deposit they offered, by the cheapness of the fares, by the quickness of the service, and by the good maintenance of the lines, etc., up to the end of their control, that the city in the end would have a valuable property. This in his humble judgment, was to be obtained by the cable system. Alderman Baxter Ellis made a strong speech in favour of the application of electric power. He thought they should pause when Leeds and Birmingham were favouring a large expenditure of capital in improving and extending their electric systems. Mr. Cairns defended the electric system from a financial point of view, and Mr. Wm. Crossling moved a motion to the effect that the meeting was of opinion that at present it was inexpedient to proceed with the Tramway Bill for the adoption of the cable or any other system, until the whole question had been referred back for further consideration. Mr. Armstrong seconded the motion, which was carried unanimously.

Provisional Orders —The Highways Committee of the London County Council reported that three applications have been made to the Board of Trade for electric lighting provisional orders this session. Two of these were by the Vestries of Battersea and Newington as regards their respective districts, and appeared to require only very slight amendments. The third order, applied for by the County of London and Brush Provincial Electric Lighting Company, and entitled the County of London (South) Order, relates to the St Saviour's district and the parishes of Newington, Battersea, Lambeth, and Camberwell. The district of St. Saviour is already included in the areas referred to in two other companies' orders, the parish of Newington in one, parts of the parish of Lambeth in two (whilst the Vestry also itself has an order), and the parish of Camberwell in two The Vestry of Battersea strongly objects to the granting of the order so far as relates to that parish, and it appeared to the committee that ample provision is made under previous orders for the electric lighting of the district referred to in the order now asked for. They accordingly recommended that the Board of Trade be asked not to accede to the application for the County of London (South) Electric Lighting Order. The report was adopted.

Aberdeen —A committee has been appointed by the Harbour Board to report as to whether the necessary current for lighting the quays should be obtained from the Corporation mains, or by generating plant to be procured by the Board. The Corporation electric lighting accounts show a profit on the past year's working of £435 0s. 9d. The income was £3,611. 8s 9d., and the cost of maintenance £1,356. 18s. Out of the balance interest on mortgages has to be paid, and large sums have been written off for depreciation on buildings, machinery, etc , and a sum put to the credit of the sinking fund—these items together making a total of £1 819. 10s., and leaving a clear balance of £435. At the June balance there was a deficiency of £109 so that the year's results are regarded as highly satisfactory. It is expected that the Town Council will on an early date reduce the price of the light by about 1d. per unit. The quantity of electricity generated in Board of Trade units was 159,777, and the quantity sold was—for public lamps, 8,257 units; to private consumers by meter, 130,115 units; total, 138 372. The quantity used in the works was 1,769 units, and the total accounted for is thus 140,141 units, leaving a leakage of 19,636 There are 10 public lamps The Gas and Electric Lighting Committee of Aberdeen Town Council have had under consideration the accounts for the year in the electrical department It was resolved that the £435 of clear profit should be utilised in establishing a reserve fund which, the Board of Trade has decided, may amount to one-fifth of the whole capital. From this fund any subsequent deficit or extraordinary expenditure may be met It was decided to recommend to the Council to make a reduction of 1d. per unit, making it 5d. instead of 6d. as at present and to reduce the meter rents by one-half.

Birmingham.—The Public Works Committee has reported in favour of a trial of overhead electric traction on the Nechells line of tramways. The length of line is about 2¼ miles, and at present the tramcars are drawn by horses, some of the streets traversed being too narrow to permit of the use of steam traction The electric current will be carried along under the footpath, and will, at intervals of 50 to 60 yards, be conducted through posts to the overhead wire, these posts, which are to carry two branching lights, being also used as lamp-posts The cars will be "actuated" by an ingeniously contrived arm, working from the top of the car, and connecting itself with the overhead wire The wire will be carried along only one side of the street, with occasional crossings at the turnout places. The committee have considered the question of danger very carefully. Their conclusion, based upon the three years' experience of Walsall, and upon the experience of Bristol and other places, is that there is really no danger, the electric current, even if the wires should break, being too weak to inflict injury. As a matter of fact the breakages of wires are infrequent, only three having occurred in Walsall during the three years, and no damage to any person resulted from these The conditions imposed by the committee are: first, there is to be no cost to the Corporation: second, the execution of the work is to be under the supervision of the Public Works Committee and of the Board of Trade; third, the extra lighting of the public lamps is to be borne by the company; fourth, an additional service of trams is to be provided by the company; and, fifth, the company undertakes, after six months' trial, followed by three months' notice from the Corporation, to remove the wires and everything connected with them.

London Lighting Extensions.—Notice under the Electric Lighting Acts and Orders has been given to the London County Council by the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Electric Lighting Order, 1892, of intention to construct 38 large transformer-boxes in the Wandsworth district; but as the Council were informed that the proposed positions of the boxes had not been approved by the Wandsworth District Board they withheld their approval so as to give the District Board a free hand in the matter. Notices have also been given by the Vestry of St. Pancras to lay mains in Great College-street; from the House-to House Electric Supply Company to lay high and low tension mains in Evelyn gardens and Cranley-gardens, to construct three transformer-boxes and three surface boxes, low-tension mains in Sussex-place, and high and low tension mains in Fulham road; by the London Electric Supply Corporation to lay distributing mains in Battlebridge-lane, Tooley-street; and from the Westminster Electric Supply Corporation

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to lay mains in South Eaton-place. The committee recommended that these works be sanctioned ; and they also recommended that sanction should be given to the application from Messrs. Ellington and Woodall to the laying of the London Hydraulic Power Company's mains in Mount street, Dover-street, St George (Hanover-square), Park-crescent, and in part of Marylebone road and part of Albany-street. The Vestry of Islington will begin to supply electricity for lighting purposes in the main thoroughfares of the parish to-day. The streets however, will not be illuminated with electricity until March. The Hackney Vestry have adopted a scheme of electric lighting in combination with a dust destructor The capital outlay will be £80,000, but it is estimated that the parish will reap a profit. During the discussion before the Vestry it was stated that Shoreditch, Tottenham, and Walthamstow were about to adopt similar schemes.

PROVISIONAL PATENTS, 1896

JANUARY 20

1396. Improvements in machinery or apparatus for transmitting motion from electric motors to other machinery. William Wilson Hulse, 46, Lincoln's-inn-fields, London.

1401. Improvements in electrical gas-reaction apparatus. Aloys Adrién Naville, Philippe Auguste Guye, and Charles Eugene Guye, 11, Southampton-buildings, Chancery-lane, London.

JANUARY 21.

1427. Improvements in and connected with telephonic apparatus. Hugo Marcuse, 70, Market street, Manchester. (Complete specification.)

1443. Improved means of intercommunication by telephone, part of which is applicable to other electrical apparatus. John James Mann 4, St. Ann's-square, Manchester.

1457. Improvements in or connected with incandescence electric lamps. Charles Frederick Stearn, 47, Lincoln's-inn-fields, London. (Charles Frederick Topham, Switzerland.)

1480. Improvements in electric gas-lighting apparatus. Edward Griffith Brewer, 33, Chancery-lane, London. (Henry Clay Farquharson and Denise Frank Root, United States.)

1487. An improved microphonic transmitter. Philippe Charollois, 45 Southampton-buildings, Chancery-lane, London.

1498. Improvements in or relating to electric batteries. Walter Grimes, 323, High Holborn, London.

1511. Improvements in the manufacture of filaments for electric incandescent lamps. Frank Eustace Wilkins Bowen, 6, Bream's-buildings, Chancery-lane, London.

1518. Improvements in means for the distribution of electricity simultaneously to circuits requiring current of uniform pressure and to circuits having variable load. Henry Edmunds, 47, Lincoln's-inn-fields, London. (Gulielmo Mengarini, Italy.)

JANUARY 22.

1559. Improvements in making gases and steam by electricity. John Henrique Dunn and John Parsons, 272, Holloway-road, London.

1563. Improvements in gravity electrical contact-makers. Richard Pearson, 53, Chancery-lane, London.

1564. An improved process for utilising peroxide of lead in the manufacture of elements for voltaic batteries. Desmond Gerald FitzGerald and Charles Nigel Stewart, 53, Chancery-lane, London.

1565. Improvements in electric switches. Thomas Harper, 55, Chancery-lane, London.

1574. An improvement in electricity meters. Siemens Bros and Co., Limited, and John Nebel, 28, Southampton-buildings, Chancery-lane, London.

1575. A process for the electrolytic production of zinc from its ores. Siemens Bros. and Co., Limited, 28, Southampton buildings, Chancery-lane, London. (Siemens and Halske, Germany.) (Complete specification.)

JANUARY 23.

1611. Improvements in and relating to holders for incandescent electric lamps. William McGeoch, jun., 96, Buchanan-street, Glasgow. (Complete specification)

1669. Improvements in or relating to electric batteries. William Turner, 323, High Holborn, London.

1678. Improvements in electrodes for electrolytical purposes. William Digby, 45, Southampton-buildings, Chancery-lane, London. (Albert Edward Woolf, United States)

JANUARY 24.

1685. Method of utilising primary induced currents of dynamo-electric machinery. Thomas Cooper, 69, Mill-street, Rycroft, Walsall.

1687. Isolator for fastening electric conducting wires. Heinrich Rudolf, 18, Petherton-road, Canonbury, London. (Complete specification.)

1695. Improvements in connection with electric tramways. Thomas Meacock, 18, Burlington-chambers, New-street, Birmingham.

1715. Improvements in and relating to ships' telegraphs. John William Ray and Robert Coleman Saxby, 26, Castle-street, Liverpool.

1775. Improvements in dynamo machines. Alphonse Isidore Gravier, 77, Chancery-lane, London.

JANUARY 25.

1782. Improvements in apparatus for testing magnetic quality. James Alfred Ewing, Langdale Lodge, Cambridge.

1793. The Inglis electrical photographic lamp for studio purposes. James Martin Inglis, 19, Queensbury-street, Edinburgh.

1796. Improvements in means for or connected with the charging of portable electric secondary batteries or accumulators. Walter Gardwood Mulliner and Wilson Henry Sturge, 12, Cherry-street, Birmingham.

1838. Improvements in electrically-driven wool-shearing or hair-clipping machines. Harry William Charles Cox and Gershon Bowmar, 1, Queen Victoria-street, London.

1842. Improvements in holders for electric glow lamps and analogous electrical contact devices. Thomas Richard Davis Kenny, 46 Lincoln's-inn-fields, London.

1843. Improvements in the means and apparatus for connecting electrically-propelled vehicles on tram and railways to fixed conductors. David Urquhart and Frank Wynne, 17, Victoria-street, Westminster.

SPECIFICATIONS PUBLISHED

1888.

11963. Electric rail, etc., systems. Smith. (Second edition.)

1892.

9983. Electrically propelling railway vehicles. Thompson. (Ries and Henderson.) (Second edition.)

1894

10169. Voltaic batteries. Blot. (Second edition.)

1895.

684. Incandescent electric lamps. Cannon.

687. Generating or transforming electric currents. Cheffey-James and Ward.

2277. Electric accumulators. Hirschmann.

15787. Electroliers, electric light standards, etc. Braham.

22985. Transmitting electric currents. Bremer.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅞-6¼
Brush Company, Ordinary	3	1-1¼
—— Non. Cum , 6 per cent. Pref.	2	1⅝-1⅞
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5¼-5⅝
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7¼
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	13½-14½
—— 6 per cent. Cumulative Pref.	10	15½-16¼
—— 5 per cent. Debenture Stock	100	124-128
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	130-132
—— 5 per cent. Pref. Shares	10	14⅞-15½
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10½-11
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¼-1⅞
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅝-¾
—— 7 per cent. Cumulative Pref.	2	2-2½
Elmore's Copper Depositing	2	⅜-½
Elmore's Wire Company	2	⅜-½
Fowler-Waring Cables	5	½-¾
W. T. Henley's Telegraph Works, Ordinary	10	13½-14½
—— 7 per cent. Preference	10	15½-16½
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4¼-4½
—— 7 per cent. Preference	5	8-8¼
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7⅜-8½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅜-8⅛
Liverpool Overhead Railway	10	12⅜-12½
—— 5 per cent. Pref.	10	15⅜-16
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅜-½
Metropolitan Electric Supply	10	11¼-12½
—— 4½ per cent. First Mortgage Debenture Stock	100	115-118
National Telephone, Ordinary	5	6⅛-6⅜
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16-17
—— 5 per cent. Non. Cum. Third Pref.	5	6¼-6⅝
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	8½-9
Oriental, Limited, £1 shares	1	1¼-1⅜
—— £5 Shares	5	7⅜-8¼
—— £4½ shares	4½	6¼-6⅞
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-106
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8¾-9¼
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	44-46
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	4⅞-5⅛
Westminster Electric Supply, Ordinary	5	8¾-9¼
Yorkshire House-to-House	5	6¾-7¼

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NOTES.

Safety Rules.—It is stated that the Japanese Electrical Association has asked the Government to issue regulations regarding electric light and power, and offered its services in preparing such a set of rules.

Tramcar Speeds.—The United States Supreme Court has upheld the Brooklyn by-law limiting the electric tramway to a speed of eight miles an hour, and six miles an hour in the more densely-populated parts of the city.

Tramways and Trees.—The running of the Coventry tramways was stopped suddenly last week owing to a branch of a tree being allowed to fall on to the overhead wires. The damage was repaired and the cars running again in less than half an hour.

Liverpool Engineering Society.—At the annual dinner of the society Mr. Maginnis, president, in the chair, there was a large attendance, amongst those present being Lord Derby (Lord Mayor of Liverpool), Mr. W. J. Pirrie, J.P. (Lord Mayor of Belfast), and Mr. T. H. Ismay.

Incandescent Gas Patents.—The German Patent Office has confirmed the patent of Herr Rudolf Langhaus. The invention consists of depositing the incandescing material upon a gauze of exceedingly fine platinum wire by means of electrolysis, so as to produce a mantle that will bear rough usage.

Power Transmission.—According to the *Elektrotechnischer Anzeiger*, the city of Guatemala, in Central America, is to be supplied with electricity for lighting and power from a waterfall 36 kilometres (22 miles) distant. The three-phase system is to be adopted, with a potential of 10,000 volts over the line, and transformers at each end.

Board of Trade Regulations.—We have received from the Board of Trade a copy of the model regulations which this Department, after consideration of the representations made by undertakers under electric lighting orders, and by associations, etc., interested in the matter, propose to adopt. The new regulations will be given in full for the purpose of reference in our next week's issue.

A High-Tension Shock.—Signor Nizzola, writing in *L'Elettricista*, says that a workman at Frankfort-on-the Main touched a wire and received a shock at a potential of 2,900 volts. Though apparently killed, he was revived by artificial respiration in half an hour. As it is stated that the man was standing in good contact with the ground, it is to be presumed that the contact with the wire was not a very good one.

Electrosciography.—This is to be the name for the process of taking photographs on Prof. Röntgen's methods. It is, perhaps, not pretty, neither are the photographs, but it has this advantage over using the same number of syllables of plain English. If one writes of the process under the title of "electric shadow printing," it offers an opportunity for anybody to say it is nothing of the sort, whereas few people will concern themselves as to the exact meaning of a word like electrosciography.

Obituary.—We regret to announce the death, at the age of 42, of Mr. Augustus Calder, which took place on the 3rd inst. at his residence, Wandsworth Common. Mr. Calder, about 15 years since, entered the service of the National Telephone Company, and rapidly rose to the position of metropolitan manager. It was under his superintendence that the complicated undertaking of metallic circuiting the telephone system of London was carried out. The death of M. Jules Reiset, the French chemist, is also announced.

New Spanish Thermostat.—The *Revista Tecnológico Industrial*, the monthly publication of the Barcelona Association of Civil Engineers, contains a note on an apparatus invented by Don Juan Vila y Forns, of Gerona, which is designed to be used as a fire-alarm, or in any case where it is desirable to indicate the attainment of given temperatures. The apparatus consists of a series of thermometers, with metallic contact points at various temperatures completing circuits containing a battery and electric bell.

The Metric System.—As evidence that the retailers of the country are not opposed to the adoption of the metric system, the secretary of the New Decimal Association calls attention to the fact that the Metropolitan Grocers' and Provision Dealers' Association have quite recently passed resolutions in its favour. The Bolton Grocers' Association also has passed a resolution approving the recommendations of the Select Committee on Weights and Measures, and urging the present Government to give effect thereto; and the Glasgow United Trades Council has resolved to the same effect.

Chemical Society.—The *Proceedings* of the society contain a note by Dr. T. Ewan on the electrolytic conductivity of formanilide and thioformanilide. The majority of the amides are too little soluble in water to allow of measurements of electrolytic conductivity being made. Others, again are decomposed by water too rapidly into acid and amine. The conductivity of formanilide shows that it possesses feebly acidic properties. In aqueous solution the sodium compound of formanilide is completely decomposed. In the case of thioformanilide, the sodium compound appears to exist in aqueous solution.

Sunshine Recorder.—An electric sunshine recorder, devised by Messrs. Hunt and Duenckel, of St. Louis, Missouri, consists of a pair of balanced bulbs filled with liquid, connected by a tube and suspended on a knife-edge. One of the bulbs has a bright surface, and is screened from the rays of the sun by a cover, while the other is blackened. The heating of the blackened bulb causes the expansion of the air in it, and drives the liquid over into the screened bulb. This disturbs the equilibrium of the pair, which tips over and causes an arm carrying contact points to dip into mercury-cups and to actuate an electric register. The cooling of the bulb allows the liquid to flow back and opens the electric circuit by bringing the arm out of contact with the mercury-cups.

Electric Fan. — In America, for climatic reasons, more attention is given to fans than in this country, and in the January number of the New York *Electrical Engineer* there is described an electrically-driven fan. Instead of putting the motor on the shaft the fan blades are arranged inside of a ring armature, with the field magnet located outside of the armature. The commutator is placed on the hub of the fan, and the fan blades are utilised as conductors between the commutator sections and the armature. In thus utilising the fan blades as conductors they are insulated from each other, and the armature ring is wound in sections corresponding in number to the number of the fan blades, the latter being, of course, electrically connected with the commutator and armature sections.

The Coming Locomotive.—Speaking at a meeting of mechanical students at Crewe last week, at which Lord Stalbridge, the chairman of the London and North-Western Railway Company, was also present, Mr. Webb, chief locomotive engineer, referred to the recent run from Euston to Carlisle, 300 miles, without stopping, and declared that he was ready, if necessary, to run trains from Euston to Aberdeen without stopping, and guarantee punctuality of arrival. He was prepared also to run electric railways,

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and he predicted that a few years hence electric trains would be run to all the great centres at a speed they could hardly now realise. From which it would appear that some form of electric traction for railway work has been considered by the officials of at least one great company.

Royal Dublin Society.—Last week at a meeting of the society, presided over by Sir Howard Grubb, Mr. Charles E. Fitzgerald, M.D., read a paper "On Carborundum, a Substitute for Emery." He said that the paper was in reality by his son, who was at present engaged at the factory at Niagara, where carborundum, the invention of Mr. Acheson, is manufactured. Carborundum was discovered in 1891. Its great hardness rendered it a very valuable substitute for emery. A discussion followed, in which Dr. Bindon Stoney, Dr. Moss, Dr. W. B. Pearsall, the chairman, and others took part. Mr. John R. Wigham read a paper on "A Method of Using Common Petroleum as the Illuminant for Beacons and Buoys." The principle was that of a horizontal wick, and the light would burn for a month.

Underground Telephone Cables.—A remarkable report appears in the New York *Electrical Engineer* as to the electrolysis of telephone cables in Pittsburgh: "Every underground cable in Alleghany City," the despatch says, "all underground wires in Bellefield, and part of the system of East Liberty and of the West End have been abandoned, the down town district practically being the only part of the system in the two cities that has escaped the ravages of electrolysis. The wires affected are the property of the Central District and Printing Telegraph Company, otherwise known as the local telephone company. The wires had recently been placed underground at a cost exceeding 50,000dol. The water companies, telegraph companies, electric light companies, natural and artificial gas companies have also suffered to a large extent."

The Riker Electric Cycle.—The New York *Electrical Engineer* gives an engraving and a short account of a motor cycle designed by Mr. A. L. Riker, and is intended to be run at a maximum speed of 12 miles an hour over ordinary roads, maintaining that rate for four hours, and thus giving a travelling distance of 48 miles. The machine is a four-wheeler, and appears closely to resemble two safety bicycles coupled together, so as to run side by side, but the rider sits high up and forward, his feet resting on a bar above the front wheels, while the motors and battery are contained in a case between the two rear wheels. Two motors are employed, each of ½ h.p. and weighing 24lb. These are geared independently to the two rear wheels. The storage batteries are of a light lead-zinc type and weigh 135lb. The total weight of the vehicle, including everything, is 310lb.

Plant Life.—In reference to the action of electricity on vegetation, M. Bonnier, in the *Revue Générale de Botanique*, states that a continuous electric light promotes the formation of chlorophyll, and brings about, at the same time, a simpler anatomical structure of the leaves. The distribution of the chlorophyll in the tissues is more extended than in ordinary daylight; chlorophyll grains make their appearance in the cortex as far as the endoderm, and even in the medullary rays and the pith. The palisade tissue of the leaf is reduced, or entirely disappears, and the epidermal cell walls are thinner, while the bark is less developed, and the various tissues of the stem are less differentiated. A discontinuous electric light is intermediate in effect between sunlight and a continuous electric light. Alpine plants cultivated under a continuous electric light exhibit points of structure identical with those of Arctic plants, which are exposed to almost continuous sunlight in the summer. In the *Bolletino* of the Italian Botanical Society, Prof. A. Aloi brings forward evidence that both terrestrial and atmospheric electricity exercise an influence on the germination of seeds and the growth of plants.

Society of Engineers.—The first ordinary meeting of the Society of Engineers for the present year was held on Monday at the Royal United Service Institution, Whitehall. On the motion of the president (Mr. S. Herbert Cox), a resolution was passed expressing sympathy with the Queen and Royal Family in the loss of Prince Henry of Battenberg. The retiring president (Mr. W. G. Peirce) presented the premiums awarded for papers read during the past year. Mr. S. Herbert Cox, the new president, afterwards delivered his inaugural address, which was devoted to a review of the gold-mining industry from an engineering point of view. In dwelling on the difficulties of a dry treatment of gold-bearing ores, the president urged the necessity which existed for a new process which would be applicable in those districts in which sufficient water could not be obtained to allow of the ordinary treatment. The chlorination and cyanide processes were described, and the hope expressed that before the present year closed even more successful results would be obtained.

Japan Tramways.—An electric tramway established at Kioto, in Japan, is described and illustrated in *L'Energie Electrique*. The tramway has been laid by the Thomson-Houston Company, and the current is taken from a central station, which supplies power to a number silk-mills as well as the electric lighting of Kioto. The source of power is a canal from Lake Biwa, which is also used for navigation and irrigation purposes. There are 20 Pelton wheels of about 120 h.p. working 12 dynamos, arrangements being made for the employment of alternating currents of from 1,000 to 2,000 volts, and a three-phase system at 2,000 volts, as well as a 500-volt continuous current, the total output being at present about 1,200 kilowatts. One curious feature is an inclined plane 700 metres long, with a fall of 7 per cent., which is used for transporting barges from the canal to the River Ujigawa, and *vice versâ*. This is worked by a cable driven by a 50-h.p. Thomson-Houston motor. The electric tramway is 18 kilometres (11¼ miles) long, and is worked with 26 cars fitted with Thomson motors. It is stated that the results of this tramway have been so encouraging that the Municipalities of Tokio, Yokohama, and Osaka have decided on adopting similar lines.

Institution of Mechanical Engineers.—At the annual general meeting of this institution the president, Prof. A. B. W. Kennedy, occupied the chair, and there was a large attendance. The annual report of the council stated that at the end of last year the number of names in all classes on the roll of the institution was 2,270, as compared with 2,222 at the end of the previous year. The council had bought a site at Storey's-gate, Westminster, with the view of providing a permanent home for the institution. Amongst other technical matters which had been dealt with by the council during the year, the report mentioned a memorial to the President of the Local Government Board for the repeal of existing statutes so far as they prevented mechanical locomotion on common roads, apart from traction engines. Should the appeal prove successful, the council were sanguine enough to anticipate with confidence the speedy development of a branch of mechanical engineering, which might even call forth an amount of enterprise exceeding anything that had yet arisen in connection with the remarkably rapid growth of the cycle manufacture. Prof. Kennedy was thanked for his services as president, and the chair was taken by Mr. E. Windsor Richards, the president-elect.

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The Chapsal Brake.—The *Compte Rendu* of the Société des Ingenieurs Civils de France gives in full the description of the Chapsal electro-pneumatic quick-acting brake recently referred to in these columns, which was communicated to the Société by M. Georges Lesourd. The details are somewhat complicated, and would be scarcely comprehensible without a reproduction of the diagrams, but the principle is controlling the working of the triple valves of the Westinghouse brake by means of electro-magnets worked by an accumulator carried on the engine. Two circuits are used, one for braking and one for taking off, and with modifications the system can be applied to most other continuous brakes besides the Westinghouse. The pneumatic action is not interfered with, so that in case of the electric apparatus failing from any cause the ordinary continuous brake remains available. The amount of braking given is much more adjustable, and in case of the brakes coming on from a burst tube or broken coupling the train still remains under the control of the driver, and can be stopped where convenient. The action of the brake, being electrical, is, of course, simultaneous on all the carriages, however long the train may be.

Technical Training.—Writing in the *Harvard Graduates' Magazine*, Prof. Ira N. Hollis considers the framing of a course of mathematics and physics. Though the views expressed are referred to mechanical engineering, they have an equal bearing on the electrical branch. Engineering, in the abstract, is a branch of both mathematics and physics, but the principal question that meets one in carrying out any problem in construction is the economic question. One of the main elements of success is a thorough knowledge of materials and their combinations into the most economical forms. The formulæ to be applied may be worked out by the mathematician, but there is always a factor or coefficient determined by experience. This experience must begin in the schools, in order that men may appreciate as early as possible the value of gaining knowledge after graduation in such a form that it can be used. The great danger to the engineer, therefore, in the exclusive study of mathematics lies in the tendency to work out everything from the ideal standpoint, and to neglect the more important practical coefficient. Again, though the study of physical science is of the greatest value, yet there is constant temptation to follow methods too refined for the workshop. The engineering student has usually little time to spend over small experiments. But the schools will develop a man whose talent and capacity for work will enable him to study and to retain the higher branches of mathematics and physics, and at the same time to grasp their practical application to the need of modern ife.

An American Notion.—The following is intended as a serious communication to a serious paper, the *Canadian Engineer*. It is entitled "Overcrowding in the Installation of Generators," and is the production of Mr. Wm. Golding, a civil engineer, of New Orleans. Mr. Golding says: "It is the practice to instal as many electric generators in a given area as the floor space will admit, never thinking that the electric fluid which is being gathered from the atmosphere may become exhausted. The object of this note is to direct attention to the probable fact, that as all of the known ingredients of the atmosphere may be separated, the quantity of electricity collectible upon a given area may be limited. As is well known, the life-sustaining property of the atmosphere, whether for animal or plant life, becomes exhausted by overcrowding, thus suggesting that the supply of electric fluid over a given area may also become exhausted by excessive and continuous withdrawal. There are many well-equipped and seemingly well-installed electric generating plants that do not deliver the current of which they are theoretically capable, and there are also many electric plants to which large additions of power have been made wherein no satisfactory results have followed, in which the failure may be due to overcrowding." It is pretty evident that the knowledge of a Louisiana civil engineer is considerably different from that of the rest of the world, and it is most kind of Mr. Golding to give his Canadian colleagues the benefit of it. It is well known how unwilling the "Britishers" are to acknowledge the immense superiority of the Great Republic upon all points and under all circumstances, but it must be sorrowfully admitted that we are quite unequal to producing anything like Mr. Golding's discovery on this side of the water.

Electrotherapeutic.—The last number of the *Lancet* contains a note by Mr. R. A. D. Daniel, M.B., formerly assistant physician at the Margaret-street Infirmary, on a case of phonic spasm successfully treated by electricity. The patient was 25 years of age, and had suffered from the complaint for over a year. It had come on gradually, and the patient described the effort to speak as being most distressing, as, though articulation proceeded, he was unable to produce any sound for an interval varying from one to two minutes. Examined with the laryngoscope nothing could be seen wrong with the vocal chords. "Under such circumstances," says Mr. Daniel, "I decided to call in the aid of electricity, and to this end used the constant current for from 15 to 20 minutes every day for a fortnight, after which time, as progress was favourable, I reduced it to three times weekly. I employed sponge electrodes of such a size and shape as could conveniently be placed on either side of the larynx, and also varied the treatment on each occasion by directing the current antero-posteriorly, placing the anodal electrode over the larynx and the cathodal one on the back of the neck. The strength of the current used varied from two to three milliamperes, and the case was treated for nearly six weeks, improvement becoming more and more apparent. It ended happily in the disappearance of the patient's malady, of which two months afterwards there had been no return." The affection described occurs so rarely that it may be mentioned that in "phonic spasm" it is the nerves governing the larynx that refuse to act, whereas in the ordinary cases of stammering it is the mechanism of articulation that is defective. There is, however, a considerable analogy between the two, and the successful treatment of the laryngeal spasm may point out a method of attacking the commoner forms of defective articulation.

The New Photography.—Prof. Röntgen's discovery, or his rediscovery, and popularisation of the anomalous radiations produced from high-vacuum discharges first noticed by Prof. Lenard has gone the round of the world, and excited such interest that it is hardly possible to look at a paper dealing in any way with scientific matter without finding mention of it, and the somewhat ghastly reproduction of the skeleton hand stares one in the face on every side. The importance of the discovery to surgical practice has been everywhere recognised, and its value in cases of bone injuries and disease, as well as foreign substances embedded in the flesh, has been put to practical test. It is evident that on this side alone there will be a demand for a suitable apparatus for producing the new radiations, and the most convenient form is a thing that it may repay the practical man to investigate. So far as can be ascertained at present, very much depends upon the quality of the glass of the vacuum tube, German glass transmitting the radiations much better than English. Also, it is most important to have a very high degree

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of exhaustion. As to the minimum conditions for an effective discharge, nothing seems to be known, some of the apparatus described being, like Mr. Campbell Swinton's, excessively complicated, while other experimenters appear to have succeeded to a certain extent with simpler appliances. Prof. Murani, of Milan, has worked with a Ruhmkorff coil and 20 Bunsen cells. Using a Crookes tube of about 10cm. diameter, and having three anodes and one cathode, he obtained the Röntgen photographs with an exposure of 15 minutes. As other experimenters have succeeded with much shorter exposures, the matter is probably a question of degree. In the laboratory of Messrs. Siemens and Halske at Berlin, Dr. Neuhauss is stated to have obtained excellent results—not only with a Hittorp tube pumped empty of air, but also with the pear-shaped glass of an ordinary electric incandescent lamp. The metal wire leading to the carbon thread was used as an anode, and a metal plate outside the glass as the cathode. The glass shone with a bluish light when the current passed through it. On the other hand, Prof. Slary, of the Charlottenburg Technical Academy, has adopted a Lenard tube containing a thin aluminium plate at the part of the tube struck by the cathode rays. Such a tube is not easy to manufacture, but would be doubtless more effective.

Life of Armatures.—The *Street Railway Review* of January 15 has a long article on the care and repair of the motors of the electric tramways of the Citizens' Street Railroad at Indianapolis. The first thing noted is the constant and careful attention given to testing by Mr. H. B. Niles, the railroad's electrician. This has not only reduced the expense from armature troubles by one-half, but has accumulated a quantity of valuable information. According to Mr. Niles, there are two things which limit the electrical life of a motor armature—namely, crystallisation and breaking of wires due to jar, and weakening of the insulation due to heat. Having no cure for the former, his ideal is to make the insulation last up to the period of crystallisation setting in. At Indianapolis this period is about two years, the cars making a high daily mileage, and there being many crossings. When an armature gets old and its insulation weak, its worst enemy is found to be lightning. Indianapolis is subject to severe thunderstorms in the summer, and in order to avoid the possibility of having a large number of armatures disabled at once Mr. Niles has devised an arrester of his own. Two No. 20 single-cotton wires daubed with shellac are twisted loosely together, and one is connected to earth and the other to the trolley. The lightning easily jumps through the two cotton coverings. The current from the wire follows, but is of such volume that the No. 20 wires are melted and the circuit broken. There are six of these fuses arranged so that as soon as one is burned out the next is automatically cut into circuit. In winding armature coils—for which the Westinghouse Company's system is adopted—advantage is taken of the high insulating properties of a coating of good copal varnish. Finally, Mr. Niles has become convinced that there is now a tendency to spend too much on inspection, and that sometimes it is a case of spending £5 on inspection to save £1 on repairs. He was formerly a believer in the practice of taking motors out and thoroughly overhauling them every six weeks. This time has been lengthened by him now to six months and the general plan of inspection and repair materially changed. He reasons that if the details are looked after every night there is nothing which should require special attention in a less time than six months, that period being the life of that part of the equipment which wears out the most quickly—viz., the bearings. The electrical part of the motor has an indefinite life, and taking a motor apart every six weeks will not add to its life. When a car comes in for its regular repairs or because of any trouble it is tested for electrical faults, but otherwise it is allowed to run until trouble shows up, as it is believed that this is cheaper than spending a lot of money hunting for trouble and not finding it.

Machine Telegraphy.—Under this title, the *Journal* of the Franklin Institute contains a paper by Mr. Patrick B. Delany on a new system of automatic telegraphic transmission. The perforator has three keys giving respectively a dot, dash, and space. Dots and dashes are distinguished on the transmitting tape by the punched hole being on the upper or lower side. A positive current is sent for a dot and a negative one for a dash. The impulses therefore are of uniform duration and the line is not more heavily charged at one time than at another, and consequently the discharge is also uniform, and the signals on the receiving tape are correspondingly regular. The receiver comprises a wheel over which the chemically moistened tape is drawn under three thin iron wires which press lightly on top. The two outside wires are electrically one, and are connected to earth. The middle wire is insulated from the others, and is connected to line. When the brushes of the transmitter drop into a hole in the dot line, a positive current is sent, and a dot is marked in the track of the middle wire of the receiver. When the transmitter brushes drop into a hole in the lower or dash line of perforations, a negative current is sent, and a dot is marked in duplicate on the receiving tape, one in the track of each of the outside wires. This impulse is but a dot in duration; but as it is meant to represent a dash, it must have something to distinguish it from the dot signal; therefore, the current is forked or divided on the receiving tape, so that all dashes are in the form of double dots, while the dots proper are single, and occupy the centre line on the tape. It will be understood that the chemically moistened tape forms the circuit between the centre wire and the outer wires of the receiver, or between the line and earth; and that all positive currents come over the line and mark in the track of the middle wire, while negative currents come from the earth and mark in the track of the forked contact, forming double dots, which are recognised as dashes. In this way, no matter how bad the "tailing" may be, it is impossible to mistake a dot for a dash, or to connect them together erroneously; neither is it necessary to have definition between successive dots or dashes. The length of the composite, single, or double mark determines at once the number of distinctive marks intended. In cable signalling, there is practically no definition as to the number of impulses in the undulations of the ink line. The proportion determines. Of course, in this system of perfectly straight marks in distinctly different lines, translation is much easier. When reading the paper before the society Mr. Delany made several experimental transmissions through an artificial line of 800 ohms resistance and two microfarads capacity, or the equivalent of an ordinary iron telegraph wire between New York and Philadelphia. Perfectly legible records were obtained at a speed of 1,200, 1,800, and, finally, 2,400 words per minute.

Motorcarts on the Reads.—In spite of the practical certainty that the prohibition of motor carriages on the common roads is to be repealed as soon as Parliament meets, the position of the experimenter in this kind of vehicle is still full of peril. Last week, at Tonbridge, Mr. Walter Arnold appeared before the local magistrates to answer four summonses for not working a horseless carriage according to the regulations of the Locomotives Act. Mr.

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Arnold urged that the Local Government Board admitted that the Locomotives Act was not intended to include such vehicles as these horseless carriages, and that the mistake would soon be remedied, but the chairman said it was not for the magistrates to enquire into future legislation, and under the present legislation they must convict. The defendant would be fined 5s. and £2. 11s. costs on the first and 1s. and 9s. costs on each of the other summonses. In reference to this case, Mr. Andw. W. Barr, hon. secretary of the Self-Propelled Traffic Association, at the request of the president of the association (Sir David Salomons, Bart.), calls attention to the issue of four summonses for one breach of the law. This is a matter which he considers calls for the attention of the Home Secretary, who should quash all the convictions but one. It may be noticed that in a similar case at Glasgow the police magistrate, after taking a week to consider the points raised, decided that he must convict, but that a half-crown fine would be sufficient. At Solihull a shilling fine has been imposed. There appears, however, to be less danger from the local police in Scotland than in England, for Mr. T. R. B. Elliot has not only made a successful run in a horseless carriage from Clifton Park, Kelso, to Ladykirk and back, a total distance of between 40 and 50 miles, but has allowed it to be recorded in the local Press, and so far he has escaped with impunity. Meanwhile, the Coventry Town Council have passed a resolution: "That a memorial to the Board of Trade be prepared, and signed by the Mayor in the name and on behalf of this Council, praying that a bill may be brought in to relax the restrictions which now hamper the transit of mechanically-propelled vehicles along the public roads." "If," said Mr. Kimber, the seconder of the resolution, "the Council could do anything to extend trade and commerce in the country, and Coventry in particular, it was their duty to do so." This is putting the matter into a nutshell. At Sheffield they have also an eye to progress in this direction, and there is to be a competition and exhibition of motor vehicles at Owlerton in the forthcoming spring. So far, however, as electric cars are concerned, it is to the Geneva Exhibition this year that we must look, and possibly the object lessons to be given there may extend considerably the ideas now held as to the possible facilities of street locomotion, and supply illustrations of readier uses of electricity. As the River Rhone is utilised to supply 12,000 h.p. to be electrically transmitted six miles to the grounds of the exhibition, elaborate electrical works can be shown, and there will be horseless cabs, driven by electricity, as well as many other appliances. It is stated that in France the new vehicles have been looked upon already with sufficient favour to encourage the starting of a company to put horseless carriages on the streets of Paris to take the place of the ordinary cab, at existing fares, and subject to the usual police regulations.

Rentgen's Radiations.—As regards further discoveries of the properties of the new radiations, little has been done during the past fortnight beyond repeating and verifying the original results. The radiations are not refracted by any medium that has been tried up to the present, though Prof. Röntgen is inclined to suspect a very small deviation by prisms of ebonite or aluminium. The relative opacity of the heavy metals prevented experiments in this direction giving any results. The rays have a tendency to spread out from the direction of propagation. This may be due to diffraction, but no interference fringes have been obtained, so that nothing is known as to the length of the wave, or even if there is a wave. As the vibrations would probably be of various periods, this is not otherwise than what might be expected. The only thing certainly ascertained appears to be that the opacity of substances to the new radiations corresponds closely to the density, but whether the two are directly proportional is not clear. Some experiments with thin metallic plates go against the supposition, but as there is probably some effect analogous to reflection at the surfaces, which must be allowed for, these are not conclusive on the point. On the other hand, it seems to make little difference whether the substance is solid or in powder, which goes against the supposition that there is either much reflection or refraction. No certain conclusion has been come to as to what place the radiations are to be assigned in the theory of light. It is probable that further facts must be awaited before much will be determined on this point. The first thing is clearly to distinguish between the Röntgen rays and the cathode rays. The latter are almost certainly molecular, since they are deflected by a magnet, and are only transmissible in a vacuum or a highly exhausted gas, since, though Prof. Lenard believed that he had got them out of the Crookes tube, they could not be propagated beyond a very short distance in air. The properties of the Röntgen rays are quite different, and resemble more closely those of ordinary light. Prof. Lodge, lecturing at University College, Liverpool, has referred to the possibility that the rays were ultra-violet light, high up in the scale of the spectrum. If so, it was probable, judging from their effects, that the rapidity of their vibration was a million times greater than that of ordinary light, or about as much more rapid than light as light was more rapid than sound. There was some evidence in favour of this, since the rays were able to diselectrify negatively-charged bodies. At present, however, he felt inclined to adopt the more sensational theory, that those rays were longitudinal waves in the ether. If so, the discovery would open up a department of physics as large as light, sound, or electricity. Prof. Schuster, referring to a corpuscular hypothesis, pointed out the fact of Newton having held that fine particles of light could pass through opaque substances. Light and sound were transmitted with differing speed through varying substances; but here, however, were rays which seemed to go at almost the same speed through everything, and which were not acted upon by a lens. There was a feeling on the part of physicists that in these rays we were on the eve of a discovery of something which would link the hitherto isolated force of gravity with that of the higher forces of nature. The general opinion on the Continent appears to be in favour of the longitudinal vibration theory. In that case, instead of adopting with Prof. Lodge an enormously rapid vibration, we are compelled to assume an excessively great velocity compared with ordinary light. It would not greatly trouble the mathematicians to modify the Maxwell equations so as to admit of longitudinal vibrations. Indeed, they would be rather pleased to do so, but there is a practical difficulty in that without an incompressible ether it does not seem possible to avoid setting up longitudinal vibrations whenever light is reflected at an angle. But these have been looked for and not found. It would be going too far to invent a medium in which these were produced and subsequently converted into transverse vibrations, though this would account for the "spreading" effect observed. Neither does it seem necessary to assume that the action on the photographic plate is indirect through the medium of a fluorescence of the glass back. If the rays—whatever they may be—are capable of exciting a vibration of a non-concordant period in the molecules or atoms of the glass, they may be considered quite capable of upsetting such an unstable system as the molecule of the silver salt.

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CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXIII.

(Specially Contributed.)

We have found when examining magnetic phenomena that, when a small piece of iron is brought into a magnetic field it acts so as to lessen the resistance of the magnetic circuit. The iron filings which we use to show the direction of the lines of force show us also what larger pieces of iron—say, iron wires—would do if they were flexible: they would bend round to make contact with each pole. The action between the opposing surfaces of a condenser is similar. The tendency is to shorten the air-space between the opposing conductive surfaces, and thus if one surface is fixed and the other movable, the latter will tend to move towards the former; and this tendency to motion can be measured. The tendency to motion depends upon the difference of electrical pressure, or the voltage, acting between the two opposed surfaces. A mechanical analogy often used to try to explain the electrical action between condenser plates is to suppose the two opposed surfaces connected by means of an immense number of very fine parallel threads. Any two bodies so connected would be drawn together if a twist was imparted to the threads. The greater the twist the greater would be the pull, and so it would be possible to measure that twist by measuring the pull. Now imagine that the opposed surfaces of a condenser are joined by a dielectric, and that the action of the electric pressure is to twist the dielectric; the twist can be made greater and greater by the application of greater and greater pressure till the stress becomes too great and a spark passes—that is, till the insulation breaks down. A very careful examination of the phenomena of static electricity has led most scientific men to the conclusion that the action in these cases takes place wholly within the dielectric or insulating medium, or the medium between the opposed conducting surfaces. Without entering further into this question, we may then take it as certain that when two conducting surfaces are opposed in the manner indicated, and one surface is fixed and the other movable, the tendency of the latter will be to approach the former when the two are under a difference of electrical pressure, and the measurement of that tendency will enable us to obtain the measurement of the difference of pressure—that is, the measure of the voltage acting to produce the pull.

Thomson's Electrostatic Voltmeters.—Lord Kelvin (then Sir W. Thomson) has given us a number of admirable instruments of the electrostatic type. His multicellular and vertical voltmeters will now be described. The multicellular voltmeters are made on the principle of an air condenser. They are intended to measure from 40 volts to 1,600 volts. One instrument has a range from 40 to 160 volts, another from 80 to 240, another from 500 to 1,600, and so on. In this multicellular instrument we have the two sets of conducting surfaces; these are shown in the section (Fig. 1). One set is movable about an axis. The motion increases or decreases the area of the opposed surfaces, and so increases or decreases the capacity of the condenser. The condenser is enclosed in a metal case for the double purpose of protecting the movable part from air currents, and from the disturbing influence of any electrified body other than the fixed portion differing from it in potential. In all the instruments the fixed portions consist of two sets of quadrant-shaped cells in metallic connection with each other, and formed by a number of parallel brass plates. These cells are fixed by an insulating support to the case of the instrument, and a terminal passes from them to an insulated binding screw on the outside of the case. The movable portion in all the instruments is in metallic connection with the surrounding case. In the multicellular voltmeters this connection is made through the suspending wire, and in the vertical-scale voltmeter and electrostatic balance through the knife-edges which support the movable part. The movable portion carries the pointer, which indicates by direct readings the difference of potential between the two parts of the condenser.

The action of the instrument, shortly stated, is as follows. When the fixed and movable plates are connected respectively to two points of an electric circuit between which there exists a difference of potential, the movable plate tends to move so as to augment the electrostatic capacity of the instrument, and the magnitude of the force concerned in any case is proportional to the square of the difference of potential by which it is produced.

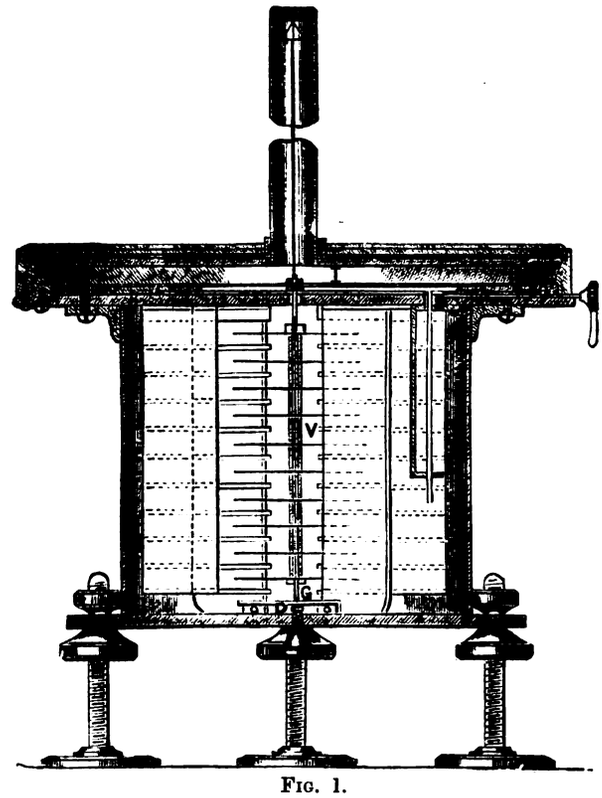

FIG. 1.

In the use of the vertical and electrostatic balance instruments this force of attraction is balanced by the horizontal components of a weight of any convenient amount being hung on the knife-edge in connection with the movable part, while in the case of the multicellular it is balanced by the torsion of the suspending wire. The arrangement of the parts of the multicellular electrostatic voltmeter is shown in Figs. 1 and 2. These figures apply

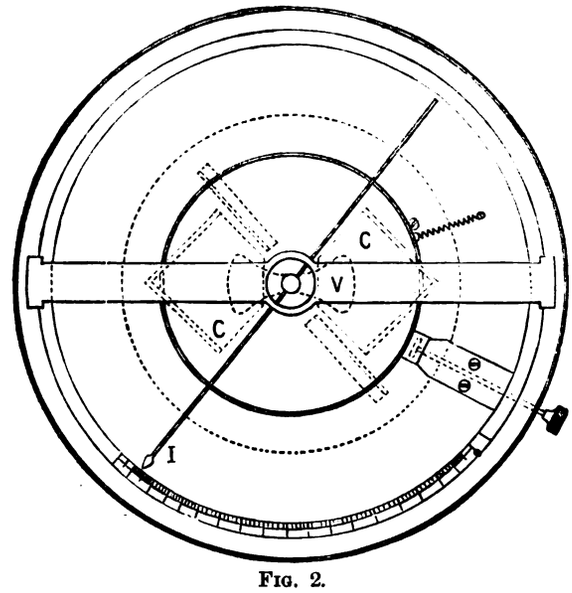

FIG. 2.

to an early form of the instrument, and differ in two matters of detail from the voltmeter as now made. For simplicity in manufacture, the cells are now made with straight backs, and the plates looked at in the plan are, therefore, triangular instead of square. A coach spring has now been interposed between the suspending wire and the spindle carrying the vanes, as explained below.

The insulated cells are formed of triangular brass plates

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fixed into sawcuts in a brass back piece, so as to be equal distances apart and accurately parallel to each other. Two sets of these cells, C, are fixed relatively to each other, as shown in Fig. 2, by a vulcanite support to the sole-plate, so that their plates are horizontal, and are completely enclosed within the brass cylindrical case of the instrument. On the top of this cylinder is a shallow

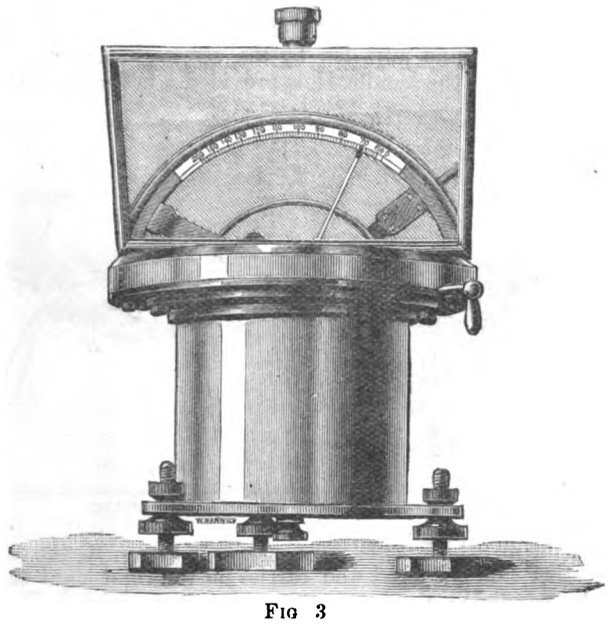

Fig 3

horizontal circular scale-box containing the scale of the instrument, and having a glass cover, which serves to protect from currents of air the movable indicator, I, and the scale and interior parts from dust. For the movable part, a number of vanes, V, similar in form to those of the quadrant electrometer are used. These vanes

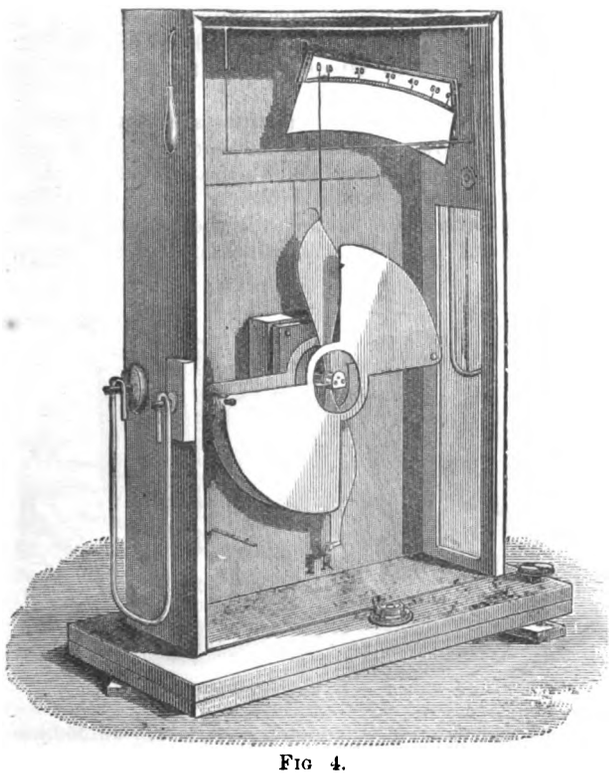

Fig 4.

are placed parallel to each other on a spindle with distance-pieces between them. The top end of this spindle passes through a small hole in the sole-plate of the instrument, which forms the bottom of the scale-box, and is attached to a small coach spring, which in turn is secured to one end of a fine iridio-platinum wire suspended from a torsion head at the top of a vertical brass tube. The coach spring has sufficient resilience to allow the spindle to touch a guard-stop, and so saves the suspension from injury in event of the instrument being roughly set down.

Two vertical brass repelling plates, which also act as guard-plates to prevent the movable part from turning beyond its prescribed limits, are fixed to the bottom of the sole-plate. These two plates carry a guide-plate, G, with a circular opening in it, through which the lower end of the spindle passes. A little brass disc, or head, D, is attached to the end of the spindle, sufficiently large to prevent its passing back through the hole in the guide-plate. Thus the moving part is effectually secured from swinging about so as to be injured, and by no possibility can it come into contact with the insulated quadrants. When the instrument is level the spindle hangs free by the suspending wire so that the vanes are horizontal, and each is in a plane exactly midway between those of two contiguous condenser plates. An aluminium needle attached to the top of the spindle indicates on the horizontal circular scale fixed to the upper side of the sole-plate the difference of potential between the movable and fixed portions of the condenser by direct readings in volts.

To enable the multicellular to be used as an inspectional instrument capable of being read from a distance, as across an engine-room, a mirror supported in a frame which passes over the vertical brass tube, and rests upon the glass cover of the instrument, is supplied. When this mirror is in position it is at an angle of 45deg. with the plane of the sole-plate, and by reflecting the scale and pointer gives the instrument all the advantages of a vertical scale. The instrument is shown in Fig. 3, with its mirror in position. A small thumbscrew is placed in the centre of the base-plate below the instrument, which can be screwed in so as to lift the weight of the spindle and vanes from the suspending wire and clamp the disc on the end of the spindle against the guide-plate. A switch is attached to the upper terminal of the instrument by which the voltmeter can be taken out of circuit when desired. The switch, after breaking circuit, puts the case and the insulated cells in metallic connection. The scale is graduated to read directly in volts.

The vertical electrostatic voltmeter is shown in Fig. 4, and, as will be seen, the insulated quadrants are supported with their plates vertical, and only one large vane is used. This movable plate is supported in a vertical position on knife-edges, so that the plane of its motion is parallel to the two fixed plates which form the insulated quadrants. Its upper end has a fine prolongation, which serves as a pointer for indicating the deflections on the scale of the instrument, and at its lower end is fixed the knife-edge for the weights, having its length perpendicular to the plane in which the plate moves.

In order to save time in taking readings, an arrangement is provided for checking the oscillations of the movable plate, and stops are placed to limit its range and prevent damage to the pointer. One of these stops, the left-hand one, is made to act as a support for the vane in the arrangement for portability described below.

The scale is graduated from 0 to 60, and the divisions represent equal difference of potential, the actual magnitude of the difference per division being dependent upon the weight in use at the time. A set of three weights is sent with each instrument, providing for three grades of measurement in the proportion of 1 : 2 : 4. Thus the instrument shows one division per 50 volts with the link (the lightest weight) alone on ; one division per 100 volts with the medium weight hanging on the link, and one division per 200 volts with all three weights on.

Ayrton and Mather's Electrostatic Voltmeter.—In this instrument both the fixed and movable conductors consist of concentric cylindrical segments. Fig. 5 shows A B C connected by D, the brass fixed conductors ; the movable segments, F E, of aluminium, rotating on the spindle, S, on which is also the pointer, P, with its counter-weight, W, to keep it at zero when no current is passing. The movable segments are carried by light aluminium frames, and are free to move within the air-space between the fixed segments. The apparatus is a modified condenser, as, indeed, these electrostatic instruments must be, one face of the enlarged conductor upon which accumulation takes place being rigidly fixed, the other conductor being movable.

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Kenelly's Voltmeter.—This is a variation of the above instrument. In it, the vertical concentric segments, A A, are of brass, connected through the frame at the bottom. Into the grooves of these segments are placed aluminium segments fixed underneath the vane, V. This vane also carries a pointer, P (Fig. 6). The system of vane and segments is carried by a bifilar suspension, C, and is through this suspension electrically connected to one of the points in the circuit.

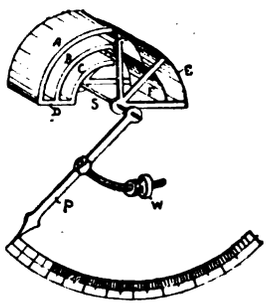

FIG. 5.

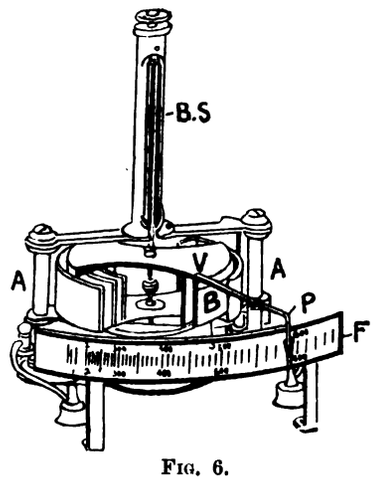

FIG. 6.

The brass segments can be electrically connected to the other point in the circuit through the frame of the instrument. "The electrostatic attraction set up between A and B causes the segments, B, to enter the grooves between the plates, A, thereby twisting the suspension wires till balanced by the torsional force of the twisted wire. Then the position of the index of the pointer upon the direct-reading scale gives the electrical pressure between the two sides of the circuit." To avoid sparking, the walls of the grooves are heavily lacquered, so that contact with the needle segments allows no sparks to pass.

ZERENER'S METHOD OF ELECTRICAL CASTING, WELDING, AND SOLDERING.*

Welding and soldering by electricity has of late years, and especially since the publication of the Elihu Thomson patent in 1886, attracted the attention of a number of professional men. There are now four systems in use—viz., those of Thomson, Benardos-Slavianoff, Zerener and Lagrange-Hoho. Each distinctly differs from the others in principle.

The actual introduction of Zerener's method into several of the larger establishments of the iron industry, enables us to fully report on it and on the latest type of apparatus employed. Mr. Zerener, as the outcome of a long series of experiments and arduous trials, states that if the magnetic lines of force of a horseshoe magnet and the lines of the electric arc cross each other horizontally and rectangularly in a plane, the arc becomes vertically diverted to this plane and resembles a blow-pipe flame. He characterises, therefore, his welding and soldering apparatus in combination with the winding of the horseshoe magnet as contrivances for producing a blow-pipe flame from the arc between two carbons. The arc is placed in such a way in a magnetic field—formed by two magnetic poles opposite each other in position—that the magnetic and electric lines of force, as before mentioned, cross each other. It may here be mentioned that it is important for practical purposes that the flame should be steady. To ensure this, due regard must be paid, not only to the quality of the carbons, but also to the combination of the solid and cored carbon rods. A special kind of core, or the passing of gaseous or solid substances through an axial bore of the carbons, may also at times be advantageous. It is essential that the carbons should be of very hard quality.

We show in Fig. 1 an apparatus for hard soldering, which is simple and light. The tube, *o*, which is fixed in a wooden handle, H, and bent, carries immediately behind the first bend a rectangular body, C^1, of non-conducting material. This holds a brass tube to guide a round rod, S^1, provided with groove, which can be moved up and down, and which carries the carbon-holder, K^1. The corresponding insulating body, C, serving the same purpose, is pivoted at the joint, *g*, and connected with the end of tube, *o*. The rods, S and S^1, are kept in place and adjusted by the screws, *s* and s^1. On the left side of the handle, H, is provided a bell-crank lever,

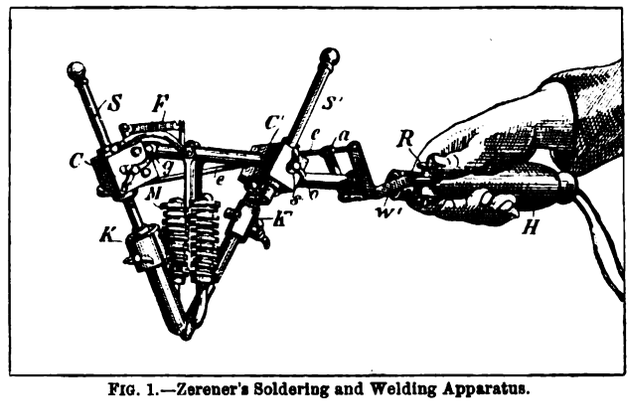

FIG. 1.—Zerener's Soldering and Welding Apparatus.

one side of which, *w*, is governed by a screw, R, whereas the other side is curved and carries on the right-hand side of the handle, at *a*, a thin connecting rod, *e*, which leads to the insulating piece, C, and can move the same. It thus causes the carbon in the holder, K, to approach the other carbon and to touch it at the point. The spring, F, tends to produce a movement in the opposite direction of the movable piece, C. The workman therefore has to turn the regulating screw, R, with his thumb to either the right or the left, according as he wishes to press the lever down or lift it up, in order to move the carbons together or to separate them. These apparatus require, according to the melting point of the respective materials to be soldered, a current of from 18 to 50 amperes with about 65 volts pressure.

The details of a larger apparatus are reproduced in Fig. 2. The apparatus, which is suspended over the work, can be moved in a horizontal and vertical direction, and is guided by means of a handle, protected from the radiant heat by sheet iron; also in this case the relative positions of the carbons and the magnetic poles are altered.

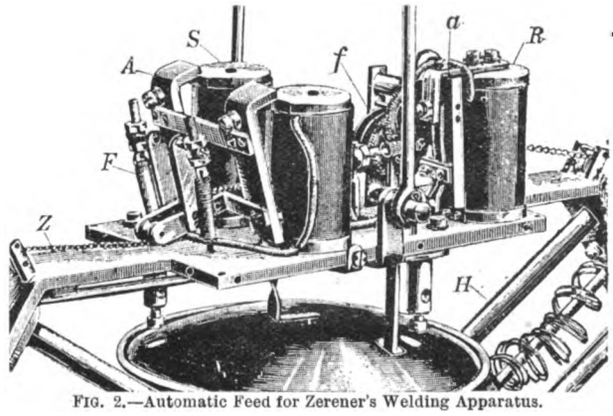

FIG. 2.—Automatic Feed for Zerener's Welding Apparatus.

The two parts, S and S^1, which carry the carbon-holders, are brought against one another through pulleys, F F^1, between the parallel-motion rods, *u* and *h*, under an obtuse angle, in such way that the point of the negative carbon comes always to be below the crater of the positive carbon. A chain, T, running over pulleys connects the movable holders with the regulating mechanism, which is placed above the triangular frame and the heat reflector, W. This regulating mechanism may vary in construction, but has to deviate so far, more or less, from that of an arc lamp, as the use of much stronger currents has to be taken into consideration, and likewise the effects of a very high degree of radiant heat. The regulating mechanism (Fig. 2)

* From the *Elektrotechnische Zeitschrift*.

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is therefore placed in comparatively high position, besides being protected by a heat reflector of German silver. The illustration shows mainly the angular frame-plate, with the commutator, R, mounted upon it, which latter effects the feeding of the carbon, and, further, the shunt arrangement, S, which, at the start, has to form the arc, and has also partly to maintain it. The slight alteration in the sliding contrivance of the carbon-holders which is shown can be entirely ignored. The commutator, R, is formed by an electromagnet in the shunt, before which an armature, *a*, provided with a cut-out, when a certain pressure is exceeded, oscillates under the influence of the spring, F, thus causing a ratchet wheel to rotate, and likewise, by means of gearing, part of a shaft revolve. The wheel is on the same axle as a pair of pulleys, with which it is connected by friction. The pulleys can be moved to and fro independent from the clockwork with which they are connected by a key on the extended shaft, which can be seen projecting in Fig. 2. Over these pulleys is the chain, T, which at this point is marked Z. The second part, S, of the regulating mechanism consists of a pair of electromagnets, in front of which are placed the armatures, A, bent at the top. To these is fixed a lever carrying two little pulleys. Two springs, F, work against the attracting power of the magnets The chain, Z, being placed over the pulleys, as shown in the sketch, the free end of it, Z^1, moves upwards and downwards with the carriage of the carbon-holders, according to the action of the armatures, A.

These self-regulating apparatus are also made for various strengths of current of from 35 to 250 amperes, and, as mentioned before, varying in construction. Special protection against the strong light and the radiant heat is naturally provided for. Zerener's spectacles may be mentioned here as well adapted for the purpose. The lower half of the glasses is of such colour that the eye can see through it straight into the welding flame without any harm to the sight, whereas the upper half is of such peculiar tint that even by ordinary daylight the work can be seen in all its details.

Zerener's apparatus are constructed and adapted for a great variety of work, and it is evident that injury to the metal can be entirely avoided by the possibility of employing the source of heat at any desired distance from the object to be worked upon, which is impossible when the latter itself, serving as electrode, is exposed to a heat of several thousand degrees. Another advantage is the possibility of regulating the heat effect of the arc. Such apparatus can be employed wherever there is a dynamo machine going, and will be found extremely useful for repairs to engines and machinery without taking them to pieces.

THE ELECTROLYTIC PRODUCTION OF CAUSTIC SODA AND BLEACH.

Step by step, with steady onward strides, electricity is establishing its position as the handmaid of our great industries. Amongst its numerous applications to industrial purposes, the latest, and by no means least, important is that of the commercial production of caustic soda and bleach. Not that this has been accomplished at one heat, so to speak; it has been the work of time and of many brains. Numerous attempts have been made to attain the coveted end, but until now the reward of practical commercial success has been withheld from those who strove hard to achieve it, and who both desired and deserved it. The history of the development of the question is a long one, too long to be entered upon here, suffice it to say that, as far as we are aware, it commenced with the introduction of the Gramme machine into this country some 23 years ago. Since that time many earnest workers have taken it up, and each has advanced it a stage until to-day finds the process perfected.

The system under notice is that patented by Colonel T. J. Holland and Mr. James C. Richardson, and which was first put in practical operation a few years since at a large paper mill at Snodland, Kent. There it was developed on a practical manufacturing scale until it attained the stage of commercial maturity. When it was demonstrated that caustic soda and bleaching powder could be expeditiously and economically produced by the decomposition of salt by an electric current, it was determined to carry on the manufacture at independent works. These were found at St. Helens, Lancashire, the situation having been selected as most convenient both for obtaining the raw materials and for disposing of the manufactured goods.

The works are situated on 15 acres of land, which gives ample room for extensions. They are intersected by lines of railway, with a siding on the North-Western system, and have a wharf on the St. Helens and Mersey Canal. The rock salt, which is obtained from Cheshire, is first dissolved in water under agitation, the brine being run off into settling-tanks, from which it is pumped up to the store-tank for the supply of the decomposing-tanks. There are 200 of these tanks, disposed in 10 sets of 20, placed tier upon tier, and surrounded by galleries at three different levels. The tanks, which are 20ft. long, are divided into 32 cells, half of these being for the anodes, and the remainder for the cathodes. The anodes are composed of pieces of gas-retort carbon set in lead or antimony backs, the cathodes being cast-iron grids. The anodes are placed in cells, which are closed in at the upper part, but open at the lower, to admit the inflow of brine. The chlorine gas which is given off at the anodes passes through closed conduits from the cells to a main leading to the bleach-chambers. The hydrogen gas given off from the cathodes escapes harmlessly into the air. Means are provided for feeding common salt into the cathode cells, in order to maintain the normal strength of the solution of caustic soda, which is run off at intervals and stored in a large tank in the caustic-shed.

We have now the two resultants of decomposition—chlorine gas and caustic soda. The gas, being heavy, is exhausted from the cells and driven into the bleach-chambers, of which there are three, each of about 12,000 cubic feet capacity. Here the gas is absorbed into the lime (which is obtained from Buxton and prepared on the works), and the bleaching powder of commerce is formed. From the stone tank in the caustic-house the solution is run into the caustic-pots, of which there are nine each of 12 tons capacity. In these the liquor is evaporated down to the required density, after which it is filled into drums for the market.

The current, which is the prime agent in the manufacture, is generated by two of Parsons's parallel-flow steam turbo-dynamos at 120 volts, each generator being capable of giving off 110 units. On the switchboard are two Weston ammeters for 4,000 amperes each and a Weston voltmeter, besides which there are 10 other ammeters for the circuits. Two horizontal brass bars run the whole length of the board at the back and 10 vertical bars in front, connection being made with massive copper plugs which put the tanks and instruments in circuit. Five cables leave each side of the board to go to each side of the tank-house. All cables used are of bare copper, including those which connect the switchboard with the dynamos, which are buried and covered with pitch. The alternate compartments of the decomposing-tanks are closed with a lid from which the carbon anode is suspended; the tanks are placed in series with each other, the cells being in parallel. There are five circuits on each side of the tank-house, each circuit making a set. Each tank requires about four or five volts to send 700 amperes through it. The connection of the main cable is effected in a very ingenious manner, which, in common with the other details of the process, forms the subject of a patent. The cable is of stranded copper, and at each terminal one strand is taken off to join on to it, and so on to the second, where another strand is joined on, the cable thus getting smaller and smaller until the last strand is taken off to the last terminal, a considerable saving in copper thus being effected.

The present output of the works is about 100 tons of 35 per cent. bleaching powder and 60 tons of 70 per cent. white caustic soda per week from 60 tons of common salt. This is produced by the plant and apparatus we have described, which we recently were afforded the opportunity of inspecting, and with which we were much pleased.

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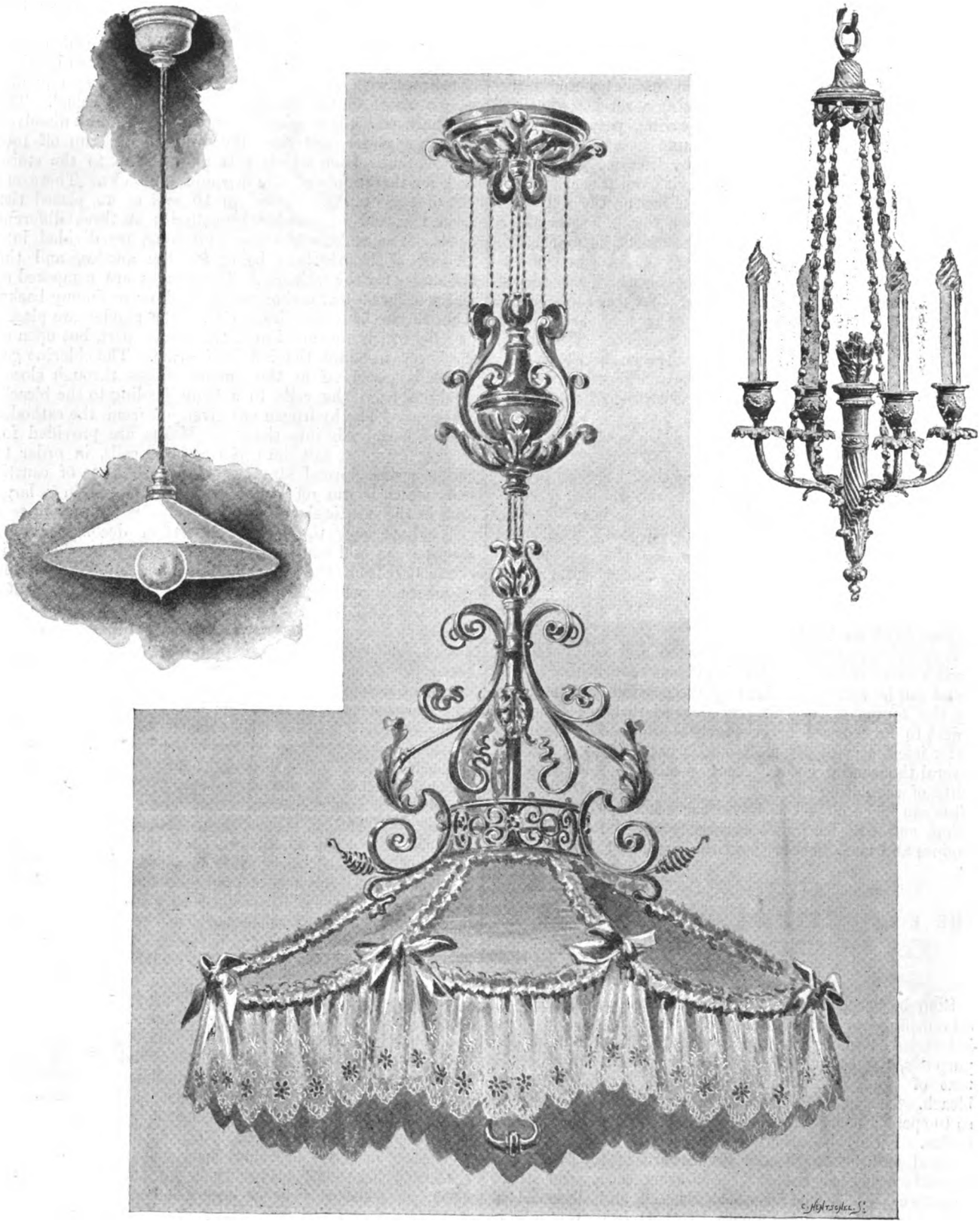
That the products were of the highest quality was shown by their appearance, and was further manifested by the business which was being done as shown by the order-book. The business, moreover, is steadily increasing, so that arrangements have been made and plant and machinery ordered to treble the present production. The extended works are to be in operation this summer, and it is anticipated that they will have to be further increased to meet the growing demand for electrolytic alkali. Altogether the Electro-Chemical Company's works at St. Helens present a practical and highly satisfactory solution to the problem of the electrolytic production of caustic soda and bleach from common salt, and their success constitutes another triumph of electrical science.

NEW LIFE.

Few buildings once used for electrical enterprises have been abandoned to other uses due to failure. We are glad, therefore, to see that the old premises of Messrs. Woodhouse and Rawson, in Cannon-street, have been taken by the General Electric Company. These premises, of which the new entrance is in 88, Queen Victoria-street, were large enough for the old firm in their most prosperous days, and yet the General Electric Company are now using them for their fitting department only. The alterations, now practically completed, have converted these premises into the most convenient and extensive showrooms for electroliers



The General Electric Company's Fittings.

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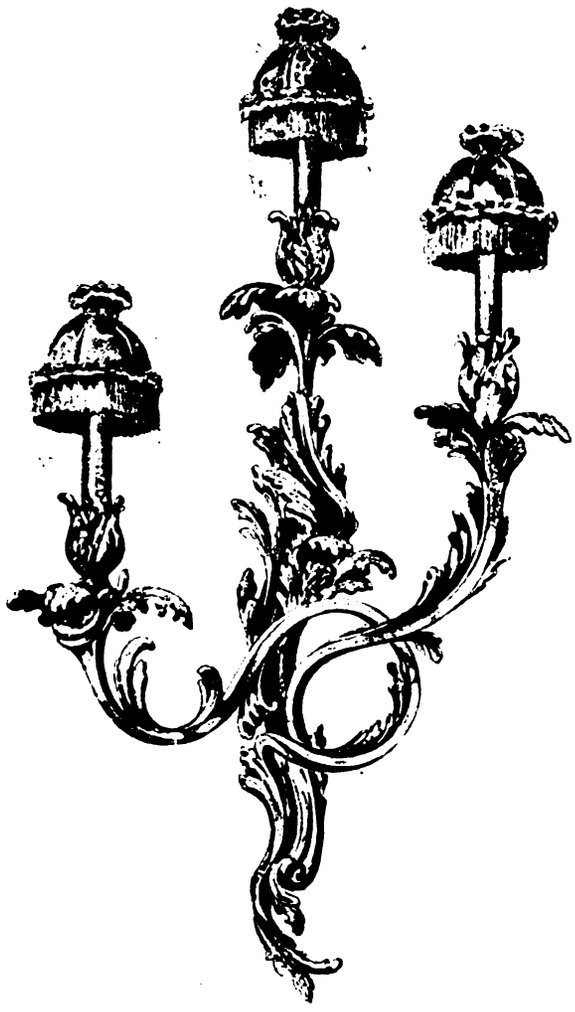

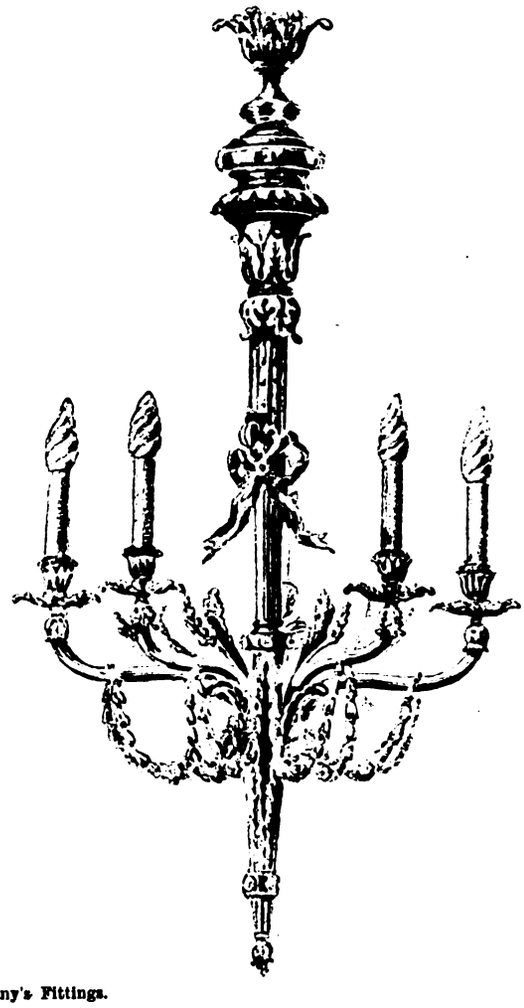

The Genera Electric Company's Fittings.

and electric fittings in the kingdom. Entering from Queen Victoria-street, the room just inside the lobby is used as an accessories department, where such necessary details as galleries, adapters, holders, cord grips, cord ornaments,

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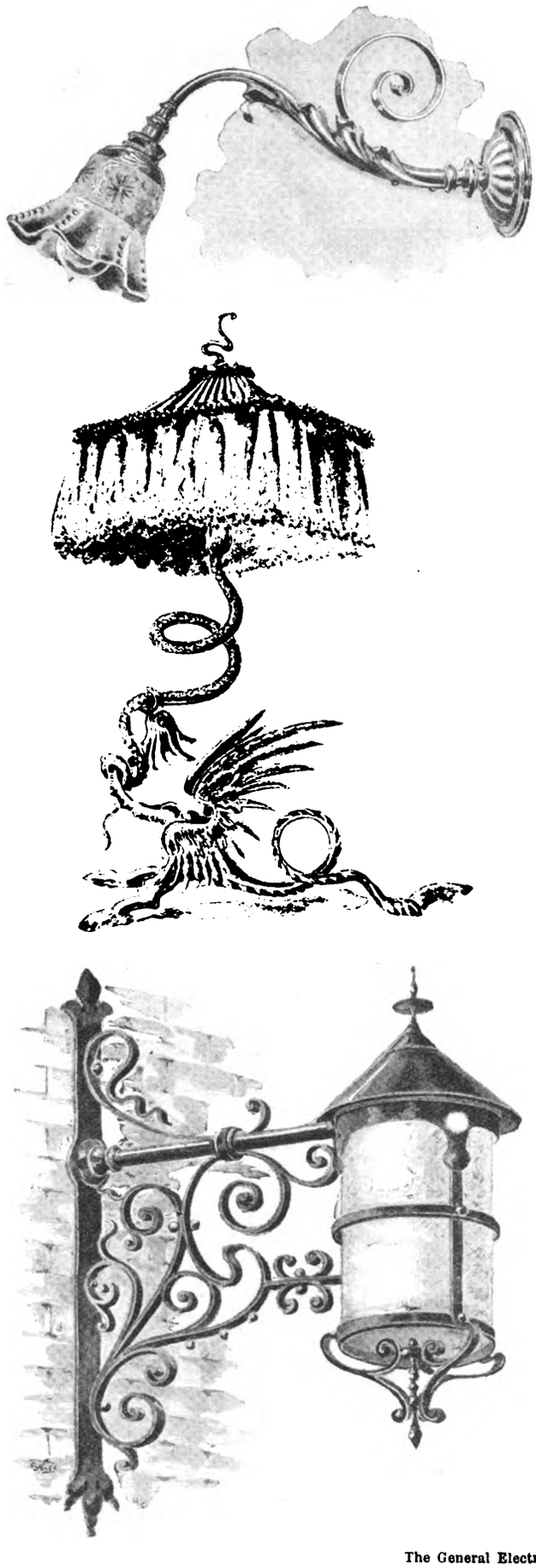
back-plates, etc., are stocked. The whole of the rest of the ground-floor forms one large showroom. This spacious department is decorated with taste, the walls being panelled and upholstered with dark-brown cloth. The panelling is also relieved with gold moulding. The ceiling is painted a terra-cotta colour and relieved with gold panelling. Dealing with the walls first, the fittings attached to the panels are arranged in accordance with the position in the company's new catalogue. This gives great facilities for identification. Every fitting is wired, and can be lighted by means of plugs and switches at the base of the panels. The fittings can thus be seen complete with lamps and shades, and as the common showroom fault of overcrowding has been avoided, a good idea of the general appearance of each article can be obtained. The whole of the ceiling is wired in two main circuits, so arranged and sub-divided that adjacent electroliers come on opposite sides of the three-wire system. This renders an equal division of the load on the main more probable. The plug and switch system on the ceiling is somewhat similar to that on the panels. The switches controlling the lights are conveniently placed in accessible positions on the walls. Two large iron columns supporting the building are the cause of a pleasing effect in the middle of the room. These columns have been encased with octangular wood panelling relieved with gold, and a series of steps at the base are used to display the small bronze pedestal fittings, etc. The floor space, which is most ample, is hence not cumbered by the usual collection of miscellaneous fittings liable to fall at the touch. The old entrance from Cannon-street is permanently closed, and the space in the lobby is used to display the various shades and glassware stocked.



The General Electric Company's Fittings.

This showroom is used entirely for the usual run of commercial goods, and these are everywhere arranged so

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that comparisons between certain fittings of a given class can be easily made. Thus all the common types of single-light pendants and shades are placed together. The artistic fittings on view are too numerous for individual mention, but the illustrations given herewith will enable the reader to form an idea of the range covered. One adjustable pendant fitting with silk shade, for dining-room purposes, which has additional lamps attached to the counter-weight for lighting the room, is worthy of individual note.

Going up to the second floor, the special fittings are on view in a room specially constructed for the purpose. A well 12ft. diameter under a skylight has been fitted with a handsome dome of blue silk plush, surmounted by a canopy of silk. The scheme of colour throughout this showroom is the rich blue always found in the decorations of the Louis periods. The upholstering in this colour is relieved with cream panelling lined with gold. The fittings shown here include examples of all the different Louis styles, as well as examples of the Renaissance and Gothic types of decoration. A number of real and original bronzes, by noted authors, are also on view which are adapted for electric pedestals and hall-lighting ornaments. Small statuary, also arranged to carry small candle and flame lamps, are also shown on the tables in this showroom.

The rest of the space on this floor is used for the designing and drawing department. The second and third floors are used as stock-rooms, and the spacious basements hold the stock of glass shades, etc. These new premises, and the goods they contain, are well worthy of a visit from an electrical engineer.

ALTERNATE-CURRENT TRANSFORMERS.

BY DR. J. A. FLEMING, F.R.S.

Dr. Fleming delivered his third Cantor lecture on the above subject at the Society of Arts on Monday last. The lecture was commenced by a short description of the proposed units of magnetic induction. Dr. Fleming threw on the screen the statement of the relations of the weber to other physical quantities. Thus, if one turn of conductor having a resistance of one ohm is linked or unlinked with a magnetic field of one weber, one coulomb of electricity is produced. An experimental determination of the magnetic field between the poles of a permanent horseshoe magnet was then made by means of a ballistic galvanometer previously calibrated by a condenser discharge. The formula, in more convenient units, reads thus: microwebers × linkages = microcoulombs × ohms. The lecturer then went on to consider magnetomotive force, which equals $\frac{4\pi\alpha\tau}{10\ l}$ where α = the amperes in the coil of τ turns, and l = the length of the magnetic circuit in centimetres. A useful approximation is the statement that the magnetomotive force equals the ampere-turns per ½in. of circuit. Returning to the question of hysteresis and the different qualities of iron, Dr. Fleming described the iron-testers invented by Prof. Ewing, one of which was on view.

Referring to the influence of the form of the transformer on the shape hysteresis curve, two such examples were shown. The one was obtained on an old Ganz transformer in which the lozenge crosses the vertical lines at a considerable angle; the other, from a Westinghouse transformer, is nearly vertical. The alteration in the angle was shown to depend on the power factor of the transformer in question. Various constants for the hysteresis formulæ given last week depending on the quality of the iron used were then given before the lecturer went on to the question of the methods of testing transformers.

He passed over the well-known three-ammeter and the voltmeter methods of measuring power as too cumbersome and too liable to error for regular use. The voltmeter methods were then discussed, and Dr. Fleming referred to the necessity of keeping the construction of the instruments free from metal parts. The old story of the errors caused by metal cases was referred to, and an interesting experiment showed the effect of the eddy-current reaction on a suspended coil carrying an alternating current when a metallic plate was brought near it. It was also stated that even concentric coils of wire might appreciably alter the readings of an instrument. Hence care should be taken when using a Siemens dynamometer, as the idle coil, although on open circuit, has often an appreciable effect.

Dr. Fleming's non-inductive resistances were exhibited and explained, as were a number of practical details of the best methods of testing transformers. Where a subsidiary transformer is used to supply the shunt coils of the wattmeter, the lecturer stated that it should be only lightly loaded to ensure accurate results. Dr. Sumpner's differential method of testing large transformers was also explained, and the fact that the hysteresis loss decreases with the rise of temperature was referred to.

THE CONSULTANT'S CONFESSION.

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He! he!
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Before my personality
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And vail.
I have unbounded faith in the reality of matter
And in my own self.
My *ego* is the *ego* of an unique being,
The *homo sapientissimus*,
Of which I am the sole representative.
I have no superfluity of ideas,
And those I have I make go further
Than any other man.
Some critics affirm that I am reaching
Second childhood;
While others declare that I have never left
The first,
Not having yet been weaned—
From contractors' brains;
But I can safely aver that my specifications
Refute their calumnies—
By their senility.
I can specify to order.
I can specify by the metre
In any metre.
I can specify in my sleep
Things that others never dreamt of,
Things they'd like to take a sight at,
So they sometimes tell me.
I am hated by all the gasworks;
But this is jealousy.
Does not my gas command a higher price than theirs?
My specification is unique,
For I can specify
The most inevitable fine
And the most uncertain bonus,
And make no extra charge.
My specification
Turns the contractors' hair grey.
My specification
Says more and means less than any other
At the price.
My specification
Is a certain cure—
For insomnia.
My last specification
Has kept a family for three years
In curl papers.
My specifications
Lick creation,
And I lick—
A corporation's boots.

Vibration and Conductivity.—Signor Murani, in *L'Elettricista*, describes experiments on the influences of vibration on the resistance of wires. To avoid the heating due to friction, the vibrations in a series of metallic wires were induced by an electromagnetic tuning-fork, wires of hardened iron, platinum, hard steel, hard copper, German silver, and manganin being tested, and in no case was any variation in the electric resistance detected by the most delicate methods. It is consequently concluded that the resistance of metallic wires is not altered by vibrations, all results to the contrary obtained by other observers notwithstanding.

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Vol. XV. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

PAPER PROFITS.

The late Lord Beaconsfield once classed statistics generally into three divisions, and his language in so doing was so impressive that doubtless all our readers will remember the characteristic headings. We feel much disposed to classify similarly the financial statements in the prospectus of the Town and Village Electric Light and Power Company, which has this week been so largely advertised. The statements in this prospectus are, we should say, generally correct, but the omission of other facts tends to put a wrong construction upon them. Thus, we do not doubt but that the eminent electrical authority quoted believes that the Parfitt system is useful for street-lighting with incandescent lamps, but we very much question if ever he would advocate its adoption for private lighting. A series system, as he states, has cheapened street-lighting for arc lamps, but the so-called grandmotherly care of the Board of Trade quite properly forbids the use of high tension on the lamps in consumers' premises. Hence we must conclude that the advantages claimed for the Parfitt system would be confined to street-lighting only. No private consumer could be connected to the series mains. Leaving, now, the technical side, we come to the following statement, that "although the Kingswood installation is for public lighting only, and bears the double expense of night duty and superintendence of plant by day without any income from private lighting, and at a contract price of less than 2½d. per Board of Trade unit (a much lower price than any public lighting undertaken elsewhere), the accounts for the two years ending April 26, 1895, show a gross profit of over 33 per cent. on the receipts. This profit is exclusive of any charge for depreciation, repairs, and renewals, or establishment expenses, items which, although heavy in proportion to the income of the partially-developed installation, will but slightly increase when the private lighting and consequent full development is completed; so that the percentage of such charges will then be very much reduced."

This is, we expect, a most truthful account of the financial state of the Kingswood installation, but the public would hardly gather from it that the gross profit of 33 per cent. is not enough to cover the charges for depreciation, repairs, renewals, and establishment expenses. The total of these charges in small stations is usually over 1¼d. per unit, which in the present case would result in a net loss of 20 per cent. The other conclusion from the report of the auditor, which is not corrected by any statement from Dr. Thompson, is that the gross profits, although showing 33 per cent., would be increased by the addition of private lighting. On the other hand, the facts of the case are, that to undertake private lighting, another system of mains must be provided at additional cost. The installation would then stand on the same footing as any other electric supply station, with the addition on the street-lighting mains on the Parfitt system. The street-lighting, however, could be just as easily supplied from the private supply mains, so that the Parfitt scheme becomes a useless additional expense. We do not consider it worth while to discuss here the doubtful question of the claimed

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advantages for this system over other series methods of supply, because in the very best attempt the engine power required and the cost of generation are not appreciably lower than with parallel systems. What we do condemn is the practice of publishing gross profits and then omitting to give *contra* items, which not only would swamp the paper balance, but would convert it into a dead loss. We would call the attention of our readers again to the fact that street-lighting in England is practically carried out at a loss by all supply companies. An expert reporting on the lighting of Canterbury by electricity even goes so far as to reckon the cost of coal only when considering the amount to be charged for public lights. In this case he put that cost down at 1·35d. per unit. We do not consider this statement a fair one to put before untechnical councilmen, but it is not likely to cause such a waste of money as the statement in the above-mentioned prospectus. It will also be noted that the prospectus was issued and the dates of application so fixed that the technical Press could not effectively exert its right of criticism in the interests of the public.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE NEW "RAYS."

SIR,—Will you kindly allow me to contribute a few remarks, through the medium of your columns, on that which forms the subject of Mr. Sydney F. Walker's letter in your last issue? I am, like many others I believe, searching for the true connection between the various manifestations of energy in the form of sound, heat, light, electricity, and magnetism. I have read Mr. Walker's letter with a great deal of interest, but some of the views put forward by that gentleman seem to require further elucidation; for instead of providing a more intimate connection between the phenomena of electricity and magnetism, there appears to be a wider gulf than ever between them. Why should they be placed so far apart in the scale of wave-lengths; and for what reason is electro-magnetism assigned a shorter wave-length even than the ultra-violet rays? It seems to lead to this reasoning: Can a current flowing through a solenoid magnetise its iron core—that is to say, instantly produce in it waves of the highest rate of vibration (leaving out the question of hysteresis) without the iron core going through the intermediate stages of sound, heat, and light? There must surely be a form of inertia wherever molecular motion is concerned, which even the hypothetical all-pervading ether being closed in by the said molecules cannot respond to instantaneously. And, again, the theory respecting the changes of wave-lengths which take place in a conductor as the current is increased does not seem to bear close investigation. Assuming for the moment the conclusions arrived at by Mr. Walker to be correct—*i.e.*, the electro-magnetic wave as having the shortest, and the electric wave the longest, periodicity: if we now consider the case of an electric current flowing along a conductor (or, as Mr. Walker puts it, a series of electric waves of a certain rate of vibration and the current is increased, being still confined to the same area), what is the result? The wave periods become condensed or shorter, passing through the stages of invisible heat, visible red, and at length to ultra-violet light. Now to logically carry out this reasoning a little further, increase the current. Should we not then obtain "pure magnetism" (if I may be allowed to use such a term), which I presume would be invisible? But if an electric current can be explained by the assumption of waves, why do these waves take the path of the conductor instead of the majority of them diverging into space, for it would naturally seem that the ether alone should offer less resistance to waves than the molecules of the conductor surrounded by ether.

One more point which to me seems obscure. Does a different rate of transmission affect the nature of the waves? Are not different wave-lengths and rates of transmission synonymous? Or can there be two or more rates of transmission for the same length of wave?

Tenterden, February 3, 1896. ALFRED H. AVERY.

USEFUL ELECTRIC LAMPS.

SIR,—I have read with but little patience a letter signed by one that chooses the *nom-de-plume* "Fair Play," and it is a palpable fact that his treatment of the matter renders this a misnomer. Anyone conversant with the subject knows that the opposite of fair play is amplified by your correspondent, who inveighs against English manufacturers, and further makes obviously personal reflections under the guise of a *nom-de-plume*. I cannot retaliate in kind, since it is derogatory to bandy words with one, who living in England, openly avows his predilection for foreign goods.

I may draw your attention to the fact that the article and advertisement referred to is based upon the report of the German commission, and that this report does not include a single exception in favour of any one of the German manufacturers; nor, to go further, not a single special make has been set down as a really good lamp. "Fair Play" desires to inform us that he knows a German firm turning out 15,000 lamps per day, and wishes us to infer therefrom that these lamps are actually good ones. I may, in the face of this statement, either take it *cum grano* or draw the inference that the special commission had none of these before them to test. I still hold the opinion that English-made lamps are superior in every point of efficiency to any imported from abroad.

My reason in replying to "Fair Play's" letter is to protest against the perversion of important trade matters, by casting unfounded doubts upon the fairness of the tests upon which the advertisements and articles referred to were based. Most of your readers are aware of the special commission appointed, consisting of central-station and other engineers, and they have condemned broadly the lamps of German manufacture—that is to say, condemning the goods made in their own country in unmistakable terms.

"Fair Play" evidently tries to confuse your readers by omitting any mention of the tribunal referred to, but convicts what he calls unfair tests without reason or logic. His vaunted output of 15,000 good lamps per day should surely be noticed by the commission instead of being obscurely advertised here under an obviously false pretence.—Yours, etc., FREDK. WALKER.

February 4, 1896.

SOUND CASTINGS FOR ELECTRICAL WORK.

SIR,—Referring to Mr. W. J. May's paper on "Sound Castings for Electrical Work," published in your issue of January 24, it would be interesting to know exactly what this "ferro-sodium" is and also where it may be procured. It seems impossible to get it from any of the chemical manufacturers of Glasgow. Perhaps Mr. May will kindly give this information.—Yours, etc., READER.

BARRACK LIGHTING.

SIR,—Would you kindly inform me, through the medium of your journal, whether any of the Government barracks are now lighted with electric light, using their own plant or taking a supply from a public supply station? Thanking you in anticipation—Yours, etc., A. HANDLEY.

[We know of no scheme for barrack lighting actually in use, but have heard of one or two proposed schemes. Perhaps our readers can give the information Mr. Handley requires.—ED. *E. E.*]

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THE ARC LIGHT.*

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S.

LECTURE III.

(Concluded from page 132.)

SOME RECENT LAMPS.

Of other feeding lamps with tilting mechanism there are several in existence. I examined a very nice one indeed some few months ago, the invention of M. Caneval, of Rouen—a shunt lamp with an escapement designed to work independently of the tilting of the mechanism.

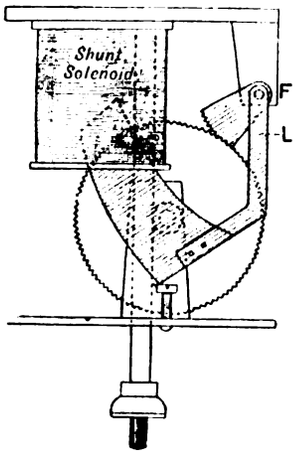

FIG. 30.

There are here two lamps of very simple construction, the invention of Mr. Akester, of London. Both are clutch lamps, and the clutch in this case works on the holder of the lower carbon rod, instead of the upper, while the clutch itself is peculiar. It consists of a little box with some small shot in it. When the small shot is compressed between the top and bottom it grips the rod, and will not let it go. When the pressure is released the shot will roll round, and the rod will slip through easily. There is no end to these mechanical devices for clamping and unclamping automatically by the operation of that which governs the lamp—viz., the electric magnetic mechanism.

Two or three other forms containing improvements in details remain to be mentioned. First, there is here a deservedly popular French lamp, the Briane. This is like the English lamps, but having only one wheel. That wheel has a kind of tooth or milling on the edge, and is governed by a small toothed

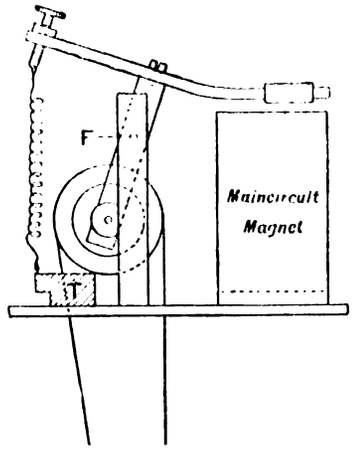

FIG. 31.

sector. That sector (Fig. 30) is fixed to a long crooked lever, having on its end a piece of iron, which can be sucked up into a shunt coil. The play of the lever is limited by a set-screw at the bottom. If the current round the shunt solenoid is strong enough, it will suck up this piece of iron and turn the wheel round a little. If the current is weak it will descend, and the wheel will turn the other way. Whenever the current through the shunt solenoid becomes very strong, the rise of this piece will carry the toothed sector out of contact, and the wheel will be free to turn. But on the descent of the carbon the current in the shunt coil will at once become weaker; whereupon the lever arm comes down again, and the wheel is once more caught. Naturally there will be wear and tear on these teeth; but the lamp seems to work very satisfactorily, both for continuous and alternating currents.

* Cantor lectures delivered before the Society of Arts.

The next picture (Fig. 31) relates to a lamp not worked by a shunt solenoid. It is called the Hard lamp. We find here, again, a single wheel on a tilting frame, the position of which is in this case governed by a main circuit magnet pulling at an armature and opposed by a spring. The wheel is allowed to turn, or is held against a small projecting piece at T. If the current in the main circuit is too strong, it is held fixed; if the arc burns away and the current gets weaker, the armature rises, the wheel is released, and feeding can occur.

THE "THOMSON 1893" LAMP."

In Fig. 32 is shown an American lamp. It is known as the "Thomson 1893" lamp, being the invention of Prof. Elihu Thomson, who has designed many successive forms since 1874.

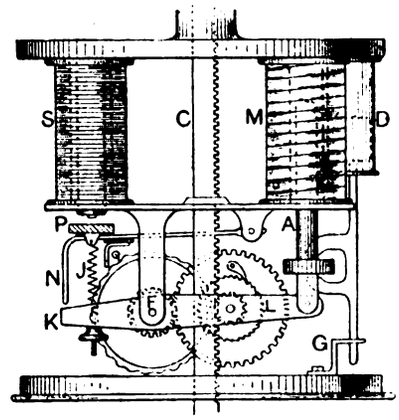

FIG. 32.

In this case a form has been arrived at which has some interesting features. M is a double solenoid, which carries the main current. The yoke, A, operates the lever, L, being, however, controlled by the dashpot, D. The lever, L, forms one side of a frame, pivoted at F, containing the wheelwork seen in the figure. The carbon-rod, C, gears with the first member of a train of wheel. The last member of the train will be seen to be a wheel with a wavy outline (the waves are much smaller and much more numerous than shown in the figure). The wavy rim is made of siiver, and against it there falls, when the lamp is working, an insulated detent, also made of silver. This detent is mounted on a lever, to which is also attached an iron strip, P, which forms the armature of the shunt coil, S. The shunt coil is somewhat sluggish in action, as it has its cores surrounded by a copper tube. The fine wire wound over this has a resistance of more than 400 ohms. The connection of the shunt is made through the silver rim and detent, so that when the detent is not in contact the shunt circuit is broken. The action of the lamp is as follows: When no current is passing, the lever, L, is down, and K being up supports N, so that the wheelwork is free and the carbons in contact. The current being turned on lifts L, and with it the carbon-rod, C, striking the arc, and at the same time allowing the detent to fall, thus closing the shunt circuit. When the arc burns long and S is strong enough, it raises the detent and the lamp feeds one tooth or wave of the silver rim, the current of S being momentarily broken. The sluggishness of S makes the action deliberate and allows the feeding to occur at variations of half a volt. Silver is an excellent metal for a contact such as occurs in this lamp, being better than platinum for the purpose. There is no pumping with this mechanism. A number of improvements in carbon-holders, dust-catchers, globe-shifters, etc., accompany the lamp. For series work a cut-out is provided, which is merely a high-resistance magnet as a shunt to the detent contact, and made still more sluggish than S, so that ordinary feeding actions do not bring it into operation, but the opening of the contact without feeding will give it time to act and close a shunt to the lamp. These lamps are also made to focus, and a modified type is employed with alternating currents.

The feature of the shunt acting as an electric bell vibrating arrangement was used some years ago in a lamp introduced by Gramme, which is but little known. The striking of the arc was accomplished by an electromagnet at the top of the lamp, and the feed occurred by the release of the last member of a train of clockwork by a lever which made a vibrating contact in the shunt-coil circuit. The lamp further resembled the new Thomson lamp in having the series and shunt coils acting independently, the former only to strike, and the latter only to feed.

THE WAX-WHEEL LAMP.

The next lamp which I exhibit is an entire novelty in the English market, though already in extensive use in America. In it all clutches, escapements, springs, and dashpots are eliminated, the feeding being accomplished by the heating effect in a shunt. To a rack on the upper carbon-rod is geared a spindle carrying between two ebonite cheeks a ring made of a white composition of wax. Into the edge of this ring is embedded

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the head of a fixed pin, which therefore prevents the wax wheel from turning. Upon the upper part of the pin is wound a coil of German-silver wire, having a resistance of about 150 ohms, which is included along with an auxiliary resistance of some 800 more ohms in a shunt circuit. The current which flows through this shunt circuit, though small, is sufficient to warm the pin and cause it to soften the wax in its neighbourhood, thus permitting the wax wheel to turn round very slowly—in fact, about one revolution in two or three hours, but very uniformly. The melted wax solidifies at once after having passed the pin, so that the surface of the wax wheel is left even for the next revolution. The feeding is therefore continuous and very gradual. Should the arc grow long more current flows through the shunt, making the pin hotter and causing the feed to work quicker. The rate of feeding is found to be approximately proportional to the square of the voltage applied to the shunt. This lamp, the invention of Mr. S. E. Nutting, can be used with either alternating or continuous currents. The arc is struck from below by an electromagnet in the main circuit, placed at the bottom. In the latest pattern of this lamp there is an automatic rheostat to vary the resistance of the shunt circuit according to the temperature of the surrounding air; and an ingenious cut-out has been added for lamps designed to run in series.

Lamps for Optical Lanterns.

Since the distribution of electric current from lighting stations became general, much attention has been given to the production of small projector lamps suitable for use in the optical lantern. These are now fast replacing the limelight, and every month sees the introduction of some new forms. The principle of making the ends of the carbon abut against a solid projection, as shown in Fig. 33, is an old one, but it has been revived by Brockie, Scharnweber, and others in lamps intended for use in optical lanterns. The form of abutment usually preferred is that of three obliquely projecting claws or screws, which grip the coned surface of the carbon. For the negative carbon, a steel abutment serves excellently. For the positive carbon abutments are less satisfactory, as they are comparatively liable to be burned away by the arc.

There are on the table, thanks to the kindness of several exhibitors, some of these modern small projector lamps suitable for lantern work. First, I ought to mention the one that has done good service during my lectures—Mr. Davenport's own, of which there are two or three varieties here. That which I have been using in the lantern has an abutment pole below, with a spring to press the lower carbon against the abutting screws. There is a hand-feed behind to move the upper carbon; and there are little details of arrangement, as shown in Fig. 34, for centreing and raising the luminous point.

Fig. 33.

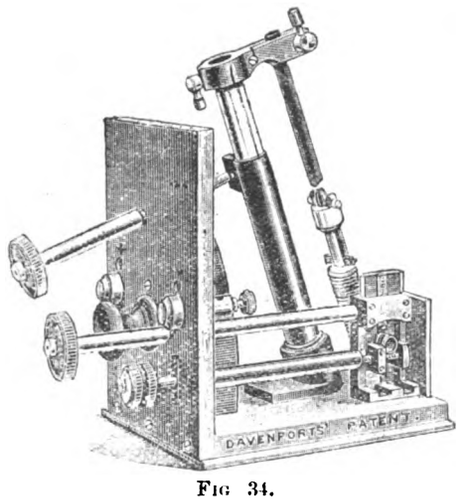

Fig. 34.

Then there are three lamps here made according to Major Holden's patent, kindly lent me by Messrs. Newton and Co., of Temple Bar. In these lamps abutment poles are used, either on the positive or negative carbons, or on both with sundry arrangements of mechanical value for changing the carbons and renewing them. Here, in the first example, are some curious contrivances to enable one to unclamp either carbon and put in a new one, as you put a new candle in a carriage lamp. In this case one has a fine hand adjustment on the lower carbon, and a coarse adjustment on the upper.

Here, again, is a somewhat similar type with hand adjustment above and below, if required. Having two sets of abutment poles, positive and negative, the carbons ought to approach at their proper rates, so that a very small amount of adjustment by hand ought to suffice. The third lamp (Fig. 35), which is of a squat pattern, is also Major Holden's. It has a device for centreing or raising and lowering the thing as a whole, and also for moving the lower carbon so as to lengthen out the arc or shorten it as desired.

Again, here is a little lamp devised by Mr. Borland, of Leeds. It has all the elements of an arc lamp in miniature—a coil to pull up a plunger and strike the arc, and a shunt coil to move another plunger to make the carbons approach one another. With carbons long enough to last four hours this lamp only weighs 3lb. I have found it to work exceedingly well on a continuous-current supply with an inverted arc, using as the lower pencil a soft-cored carbon. The upper carbon, of smaller diameter and uncored, should be set slightly in front of the lower.

A very simple hand lamp, with screw feed, by Mr. A. J. Beaumont, of York, has lately claimed some notice; but I have not had any experience with it.

Mr. Brockie has designed a very perfect small projector lamp with a vibrating clutch feed, in which, also, abutment stops are provided for the negative carbon; but it belongs in reality to the class of lamps with complex mechanism, and, therefore, can scarcely be classed with the simple lamps just mentioned.

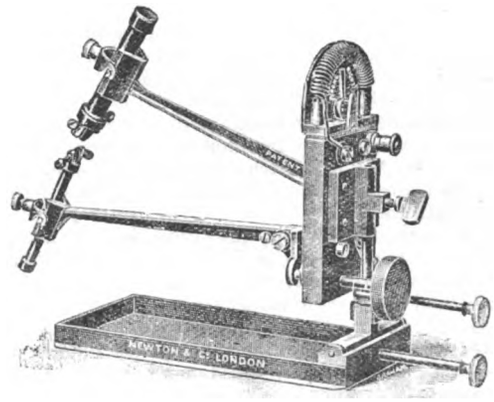

Fig. 35.

One thing has not yet been attained by the inventors of any of the automatic lamps—namely, the production of a lamp that, without any adjustment whatever, shall be capable of being connected up straight to the 100-volt mains of any lighting system, whether the supply be of the continuous or the alternate current sort. The fact is, the universal lamp, which will go anywhere with any sort of supply, has not yet been invented. Perhaps it never will come exactly in that form.

Lamps for 100-Volt Circuits.

There is another direction in which progress has been taking place during the past few years—viz., in the perfection of lamps for the special purpose of running two in series on the ordinary 100-volt mains with continuous current. It is a curious fact that lamps which will work excellently when there are a lot of them in series supplied with a continuous current of fixed value are often difficult to coax into good working when put two in series across 100-volt mains. Some lamps will not work at all. The inventor, however, has turned his attention to the question, and it is now often one of his most important claims that his lamp will work well under these conditions.

There is a somewhat similar problem how to make three lamps work in series when you have an alternating-current supply at 100 volts. They only want 30 volts each, and therefore there ought to be room for three in series across 100-volt mains. The successful solving of that problem surely must depend on some very simple thing. Now that we have methods of testing the nicety of feed, and of adjusting the volts at which the feed will occur, clearly the time ought not to be very distant when one can say that the problem of making lamps to work satisfactorily, two or three in series on 100-volt mains, shall have been really finally solved. Mr. Brockie has remarked to me that none of the old lamps which have glycerine dashpots to prevent the top carbon moving downwards quickly would ever perform this function, for if you would have two lamps to work satisfactorily, and not to go see-sawing one against the other, the one burning dull when the other is bright, they must be capable of dropping their carbons down into contact at the same instant, so that one shall not get down before the other, and strike its arc before the other is ready. They may move up slowly, but they must move down quickly. That is apparently one condition—possibly not the only condition—for the successful working of lamps in series.

Then I think I may conclude here, though time is all too brief for this review of progress since 1889, by saying that there are distinct lines of progress which have been traced in these six years, and that those lines of progress, although they may not yet have brought us everything we desire, nevertheless have witnessed the development of arc lighting into a condition where success has for almost every conceivable purpose been attained. It now remains only to perfect refinements for special purposes, such as those to which I have just alluded.

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THE STANDARDS OF LIGHT.*

BY W. J. DIBDIN, F.I.C., F.C.S., ETC.

On December 21, 1888, I had the honour of reading before the Society of Arts a paper on the subject of the standards of light, in which paper I discussed the position of the question as it then stood, summing up briefly the results of the various enquiries conducted from time to time by authorities in this country and on the Continent. The position in which the question had then arrived may be shortly put thus: The authorities of the Board of Trade—the controlling authorities for gas-testing purposes in London—the gas interest generally, as represented by the Gas Institute and the British Association, had all joined in one condemnation of the existing candle, and in demanding an alteration; and, with one exception, that such alteration should consist in the adoption of Mr. Harcourt's pentane air gas-flame.

After careful consideration of these facts, an impartial observer would probably have drawn the conclusion that the time was then ripe for a change, and that legislation would follow without delay. Unfortunately, other counsels prevailed, and we have now arrived at a period seven years later, without the attainment of the alteration so earnestly desired and looked forward to by all those who have made the subject one of special study, and who daily experience the discomfort of having their best endeavours marred by the imperfect nature of the standard employed, as by Act of Parliament they are compelled to use the long since discredited candle instead of one of the known reliable substitutes.

In view of the uncertainty prevailing in the minds of the parliamentary experts of the Board of Trade rather than in that of their scientific advisers, a further series of enquiries was instituted by a committee appointed by that Board on December 23, 1891. The committee was composed of representatives of the two controlling authorities for gas testing in London—viz., the City and the London County Council; the three large gas companies—viz, the Gaslight and Coke, the South Metropolitan, and the Commercial Gas Companies; the gas referees; and two independent representatives of the Board of Trade. In connection with the apppointment of this committee, it is to be noted that it was not until the South Metropolitan Gas Company came forward with an offer to meet the expenses of the committee that it was constituted, as neither the Board of Trade nor the controlling authorities had funds at their disposal for that purpose. Probably this action on the part of a commercial company forms a stronger argument in favour of the long-desired alteration than can be put into words.

After three years of most patient work, during which all the points were carefully and exhaustively reviewed, that committee issued its report, and the question has consequently taken one more step forward, although, as a matter of fact, the scientific result is, to all intents and purposes, in much the same position—viz., the candles are (if possible) still more hopelessly condemned—and one of the proposed more reliable substitutes recommended for adoption in their place. Mr. Harcourt's pentane standard has again been vindicated as a reliable and exact standard; and for practical use in gas-testing the pentane-Argand, proposed by myself in 1886, has been chosen as a suitable substitute for candles in daily work.

It is to be hoped that the unanimous report of a committee expressly selected so as to include representatives of all the various interests concerned will result in speedy legislation, and thus at last put an end to a controversy which has been one of the vexed questions of the day for over 20 years. In the meantime, it will be desirable that the essential features of this last official report should be fully discussed, and, with that view, I venture to submit the following summarised account of the work of the committee as given in the report. The various points may be considered in the following order:

1. Unsatisfactory standard furnished by the flame of a sperm candle, by reason of the amount of light which it affords varying over a wide range, under conditions as to the manufacture of the candle, as to its mode of use, and as to the adventitious circumstances attending its use, which, as a whole, it is not possible to regulate and define.

2. The advisability of continuing to express, as heretofore, in official documents and reports, the quantity of light yielded by coal-gas burned under specified conditions, in terms of candle-light, the actual comparison, however, being made between the gaslight and some well-defined and constant light ascertained to be equal in quantity to, or a definite multiple of, the average light given by the standard sperm candle.

3. The conclusion that, in the present state of experience and knowledge, the source of light to be used as a standard by gas-testers generally must be produced by the process of combustion, and be in the nature of a flame.

4. That the one-candle light flame proposed by Mr. A. Vernon Harcourt does constitute a very exact standard, capable of being reproduced at any time without variation of illuminative value, and that this flame is a true representative of the average light furnished by the sperm candle flame constituting the present standard.

5. Inasmuch, however, as there is a practical advantage in comparing directly the light of such a coal-gas flame as is usually tested (being, that is, of about a 16-candle light value), with a light approximating somewhat in value thereto, the committee submitted to careful examination the flame of the 10-candle light pentane-Argand proposed by the author as a standard in 1886. This flame is produced by burning a mixture of air and pentane vapour from a suitable Argand burner provided with an opaque screen, by which the light from the upper portion of the flame is cut off. The screen being set at a definite height, the luminosity of this portion of the flame remains constant even under considerable variations owing to a compensating action affecting the lower or exposed portion of the flame.

6. The amount of light emitted by the lower portion of the flame is substantially equal to 10 times the average light of a standard sperm candle flame, or to 10 times the light of Mr. Harcourt's one-candle light pentane air-gas flame.

7. That any number of the Dibdin Argand burners may be produced, and may be depended upon to furnish a flame giving, when duly screened at the top, 10 times the average amount of light given by a sperm candle.

8. Then follows the recommendation that the pentane-air flame furnished by this pentane-Argand burner be accepted as giving the light of 10 standard candles, and that it be authorised and prescribed for official use in testing the illuminating power of the gas supplied by the London gas companies.

9. With a view to making some provision for future possible improvements and requirements, the committee further recommend that the gas referees be authorised, should they at any time see fit, to approve and certify for gas-testing any other flame based upon the 10-candle standard defined above which they may consider suitable for the purpose, whether produced in a like or unlike way, and having the same or a different multiple value; such other flame, however, not to be used for gas-testing unless approved by the Board of Trade, and unless the gas companies give their consent to its adoption as a standard.

10. The committee then proceeded to recommend that the illuminating power of coal-gas shall continue to be recorded, as heretofore, in terms of the light given by a specified number of cubic feet—to wit, five cubic feet—burnt per hour from the standard London Argand burner, but that the requirement that the gas shall actually be consumed at that rate be rescinded, so as to allow the gas referees to sanction a mode of testing in which the gas shall be burned at whatever rate is found requisite, in order that it may give a light equal to that of the prescribed number of candles, and in which the illuminative value of the gas shall be calculated as being inversely as the rate at which such gas had been burned during the testing, so as to give this amount of light.

The chief error in the amount of light emitted by a candle is due to variations in the character of the wick employed. Exhaustive experiments have shown that the number and size of the threads in the wick, the closeness of the plaiting of the strands, the pull on each strand during plaiting, the previous cleaning of the cotton used, the treatment of the wick by the manufacturer, and the extent to which the wick is stretched when set in the candle-mould by the workman, are all factors of considerable importance affecting the light which a candle gives. Various other conditions also affect the result, such as the length of time it has been burning, whether the "cup" of the candle is dry or contains melted sperm, the roughness or smoothness of the wick, the curvature of the wick, etc. Added to these difficulties, we have the impossibility of making candles which will burn 120 grains an hour. The gas referees' instructions allow the use of a candle burning within 5 per cent. of the prescribed amount, but even this does not overcome the trouble, as candles very frequently burn outside these limits, departures of even 10 to 20 per cent. being by no means unknown.

In Germany sperm candles have been abandoned for paraffin candles, made under the supervision of the authorities, and specially marked; but the same troubles are experienced as with the sperm candles.

The committee, therefore, unhesitatingly recommended the abolition of the candle as a standard of light, and the introduction of some more reliable unit.

The decision of the committee respecting the continuation of the practice of stating the quantity of light in terms of the candle will doubtless recommend itself to all persons interested in the question. The unit thus expressed is one which is well understood generally, and whilst being in itself convenient, represents a quantity of light which is practically the smallest used in daily life. It is only exceptional radiants, such as the arc light, concentrated by a lens, that emit larger multiples of this unit than a few hundred times its value, and no inconvenience can be experienced in such cases; whilst the introduction of a new term, such as the "carcel," would lead to unnecessary confusion.

* Paper read before the Society of Arts.

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The expression of opinion that the source of light to be used as a standard must be produced by the process of combustion, and be in the nature of a flame, is well advised in view of the experience of the past. As I pointed out in my previous paper in 1888, numerous investigations had been made as to the possibility of producing a constant light by a process of incandescence of solid bodies, notably platinum; but the unreliability of such methods was well illustrated by the researches of the British Association Committee, aided by the work of this society, through its secretary, and since that time no progress seems to have been made in this direction. The suggestion to obtain a constant light by means of the incandescent electric lamp has completely broken down, in consequence of the more or less rapid depreciation of the initial intensity, owing to the gradual discolouration of the interior surface of the glass globe.

The following series of special experiments on this point will serve to show the difficulty with which such a standard would have to contend. The tests were made when the current was practically constant:

Number of hours the lamp had been alight.	Illuminating power.
0	14·8
96	14·0
188	13·0
307	11·5
357	11·8
453	10·8
520	11·5
612	10·5
709	10·3
761	10·5

The loss of 5·4 per cent. in the first 100 hours might not be considered an insuperable difficulty, as a lamp could be renewed at more frequent intervals. Another practical difficulty, however, is the variation in voltage of the current, a loss of only 3 per cent. having been found to affect the quantity of light by as much as 27 per cent. From these facts it will be seen that the committee had good reasons for their decision.

The conclusion that Mr. A. Vernon Harcourt's pentane-air gas flame constitutes a very exact standard is only one more piece of evidence in favour of the admirable work of that gentleman. Although the particular form in which the pentane and air are to be employed, if the decision of the committee takes legal effect, has been varied by the introduction of the pentane-Argand burner, the thanks of the community are due to Mr. Harcourt for first calling attention to the standard combustible material thus adopted. Without his preliminary investigations in this direction, it is probable that the question would have still been further from solution than it is at present. It is, indeed, only due to that gentleman to place on record once more the altogether admirable work with which his name is associated.

It is to be noted that the work of the committee resulted in the discovery of a point in connection with the one-candle pentane-air gas flame which had been overlooked in certain previous investigations. This was that, when the flame was set by an observer who viewed the whole of the luminous portion the tip of the flame was set too high as compared with the settings made when the body of the flame was obscured by a screen. A number of experiments made to determine the error thus introduced gave a mean difference of 2·59 per cent. On applying this correction to those average results obtained by means of the pentane flame, when it was set without the use of a screen, the committee found the following values of the pentane-air gas flame as obtained at various periods by different observers who had compared this proposed standard with candles:

Observer.	Value in standard candles.	Date.
Mr. Vernon Harcourt	0·994	1879
Messrs. F. Livesey and W. Brown	0 990	1879
Mr. Harold B. Dixon	0 998	1881
Mr. Dibdin	0·998	1887
,, or, including all experiments	1 016	1887
British Association Committee	1 006	1888
Mr. Greville Williams (a)	1 008	1891
Mr. Greville Williams (b)	1 050	1891
Prof. Harold B. Dixon	0·998	1891 2

The mean value of all experiments made between 1878 and 1892 with the pentane unit against standard candles when thus corrected, ascribes a value of 1 007 to the pentane flame. If one abnormally high result be omitted, the value becomes 1·001.

Satisfactory as this result was, it was nevertheless felt that in order to reduce as far as possible any errors which atmospheric influences might introduce, it would be best to adopt for the daily testing of gas a standard burner giving a light nearly approaching that of the flame to be tested, which can be easily worked, and in which slight errors in manipulation shall not give rise to serious errors in the results. The 10-candle petane-Argand seemed to satisfy these conditions, and the committee undertook the requisite experiments to determine the point. The burner used was supplied by Messrs. Sugg and Co., and on standardising it under the prescribed conditions by the one-candle pentane-air gas unit, it was found to give a value of 10·004 candles. The preliminary experiments to ascertain if very extreme variations in the height of the flame affected the amount of light given out showed that, with the extreme limits possible, which could never be approached with the most careless manipulation, the deviation from the normal value would only raise the standard by 1·0 per cent. or decrease it by 6·2 per cent., this latter result being obtained when the flame was tailing above the top of the chimney! An extended series of observations was made to ascertain within what limits of height of flame the light passing under the screen of the standard burner remained constant. At the same time the effect of replacing the air with coal-gas was tried to see whether any, and, if so, what, difference would be caused thereby. The result showed that both with air and with coal-gas the 10-candle pentane-Argand gave practically uniform results with a flame burning between the limits of 2½in. and 4½in. in height, whilst if by any mischance these very wide extremes should be exceeded, the results obtained are slightly in favour of the gas being tested. In like manner, experiments made to ascertain whether the depth of pentane in the carburetter influenced the light by altering the amount of air space over the surface of the pentane resulted in showing that as long as there is sufficient pentane to cover properly the bottom of the carburetter, the results obtained will not vary, whilst they again established the fact that atmospheric air may be used instead of coal-gas as the carrying medium. Another most important point is that the temperature of the carburetter may vary about 40deg. F.—viz., from 40deg. to 80deg. F.—without influencing the value of the standard. The only alteration found was in one case, when the level of the pentane was too low; but when the carburetter was kept about half full of pentane the results were constant.

Testings were further made to ascertain what change, if any, the 10-candle pentane-Argand might undergo as the atmospheric pressure varies. From these the conclusion was drawn that the value of the standard is not materially affected by such variations of atmospheric pressure as commonly occur.

(To be continued.)

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

February 11, 8 p.m.—At Great George-street, Westminster, S.W. Ordinary meeting. "The Manufacture of Aluminium by Electrolysis, and the Plant at Niagara Falls: Its Extraction," by A. E. Hunt, M.I.C.E.

February 14, 8 p.m.—Students' meeting. "The Construction of the Molong to Forbes Railway, New South Wales," by Sidney Thow. Stud.Inst.C.E.

Institution of Electrical Engineers.

February 7, 8 p.m.—At 28, Victoria-street. Students' meeting. "The Construction of a Form of Wheatstone's Bridge Box," by Gustave J. Lemmens, Student.

February 13, 8 p.m.—At 25, Great George-street, Westminster. Ordinary general meeting. Continuation of the discussion on "The Electric Wiring Question," by F. Bathurst (associate), and "Concentric Wiring," by Sam Mavor (member).

Northern Society of Electrical Engineers.

February 10, 7.30 p.m.—At Palatine Hotel, Hunt's Bank, Manchester. Council meeting. 8 p.m., ordinary general meeting. "The Paralleling of Alternators," by Robert Hammond (member).

Physical Society.

February 14.—Annual general meeting. "The Determination of High Temperatures with the Meldometer," by W. Ramsey and N. Eumosfopsulos.

Society of Arts.

February 10 8 p.m.—At John-street, Adelphi. Cantor lecture on "Alternate-Current Transformers." Dr. J. A. Fleming on "The Employment of the Transformer" (conclusion)

February 12, 8 p m. Ordinary meeting. "Water Purification by Means of Iron," by F. A. Anderson.

February 13, 4 30 p.m. Indian Section. "Punjab Irrigation—Ancient and Modern," by Sir James Broadwood Lyall, G.C I E, K C S.I., late Lieut.-Governor of the Punjab.

Institution of Junior Engineers.

February 7, 8 p.m —At Westminster Palace Hotel, Victoria-street. Ordinary meeting. "Water Turbines," by F. W. Lowe (member).

February 14, 8 p m —"The Stability of Tall Chimneys," by F. J. Bancroft B.Sc. (member).

North-East Coast Institution of Engineers and Shipbuilders.

February 14, 7.30 p.m.—At Lecture Hall of Literary and Philosophical Society, Newcastle-upon-Tyne. Ordinary meeting.

Institution of Engineers and Shipbuilders in Scotland.

February 11, 8 p.m.—At 207, Bath-street, Glasgow. Third meeting of Graduate Section.

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INSTITUTION OF ELECTRICAL ENGINEERS.

The following is a synopsis of a paper on the construction of a form of Wheatstone's bridge box to be read by Mr. Gustav J Lemmens at a students' meeting on Friday. February 7, 1896 :

Object of present paper. Cost of usual types of boxes, £10 to £50 Below £10 no boxes measure with greater accuracy than ½ per cent., and above £50 they may be considered as standards.

Dimensions of boxes. Peculiarity in proportional coils. Seventeen arm coils and a stretched wire. Overall dimension, $23 \times 9 \times 10\frac{3}{4}$ Nominal range, 0—200 megohms. Accuracy. Drawbacks. General consideration of errors due to (*a*) uncertainty of temperature, (*b*) faulty adjustment (these in the above-mentioned boxes amount combined to ·05 to ·1 per cent.) ; other sources of error, (*c*) imperfect contacts, (*d*) thermo-junctions. Temperature error and its cure. Usual method of ascertaining temperature faulty. Relative temperature of atmosphere, coils, and interior of box. Coils. Choice of material limited to German silver, platinum-silver platinoid, and manganin. Superiority of manganin. Comparison of properties :

	A.	B	C.	D.
Pure annealed copper	1·624	·388	3s. 4d.	—
German silver (Cu4. Ni2. Zn1)	20·9	·044	6·5d.	+15·5
Platinum silver (Pt2. Ag1)	24·36	·031	50s.	—
Platinoid (Cu4. Ni2 Zn1. W.) trace	32·8	·021	4·8d.	—
Manganin (Cu84. Mn12. Ni4)	42·0	·0025	3·5d.	+ 1·5
Iron	—	—	—	- 14·5
Other alloys in common use	—	—	—	+20 to 30

A = Specific resistance legal microhms per cubic centimetre at 0deg. C.
B = Temperature coefficient per cent. per 0deg. C. over ordinary range.
C = Cost of wire for 10-ohm coil of 22-mil wire D.S.C.
D = Thermo E M.F. against pure electrolytic copper in micro volts per 0deg. C

Dr. St. Lindeck on manganin. Temperature coefficient negligible for most purposes. Curve of temperature coefficient exhibited. Treatment and constancy of manganin.

Household oven suitable for annealing. Errors of adjustment in coils. Usual mode of adjustment. Specimen bobbin exhibited Disadvantages

Suggested improvements in methods of winding coils Apparatus for winding coils exhibited Shellac used instead of paraffin for insulating, probably on account of annealing. Reason for anneal ing. Process of adjusting coils. Suggested improvements Accuracy attained in first coil adjusted by this method = 02 per cent., with very little trouble in one-ohm coil. Further accuracy of coils ensured by device due to Prof Ayrton. Errors introduced by imperfection of contact. Usual form of plug : difficulties of construction and unreliability. Special form of mercury-cup proposed. Block must be made of copper, not brass. Device for securing against leakage of mercury.

Sizes of wire. Sizes usually employed Sizes proposed Accuracy of measurement depends on knowledge of temperature. Usual accuracy of coils ·05 to ·1 per cent. Standard of accuracy proposed = 005 per cent., allowing an uncertainty of temperature of 2deg. C. Emissivity of coils taken as ·00706 watt, or 001681 calorie per second, per square inch exposed per degree C. excess temperature. ∴ watts given to coil ÷ watts emitted per degree C. = 2deg. C. This temperature is never reached. List of sizes of wires, carrying capacity of each coil in amperes for given rise, volts at terminals, and time to acquire a rise of 95 per cent. of 2deg. C. exhibited. Specimen curves to latter exhibited. Calculations of carrying capacity and temperature curve.

Final details of box. Special tool for boring mercury-cups. Stretched wire, materials, manganin gilt, platinum-iridium or platinoid. Objection to gilt manganin lies in proximity to mercury. Method of obviating this difficulty. Means adopted for keeping wire accurate while in use.

KINGSTON-UPON-HULL ELECTRIC LIGHTING ACCOUNTS.

The accounts of the Electric Lighting Department for the year ended December 31, 1895, have been issued. The capital expenditure during the year amounted to £6 398. 2s. 4d , and the total expenditure to December 31, 1895, has reached the sum of £45,429. 16s. 1d. We give below the revenue account and general balance-sheet for the past year :

GENERAL BALANCE SHEET.

Liabilities	£	s.	d
Net revenue account—Balance at credit thereof, December 31, 1893	13	2	4
Balance at credit thereof December 31, 1894	996	2	2
Balance at credit thereof December 31, 1895	1,263	0	4
	2,272	4	10
Amount due to treasurer—Revenue account to December 31, 1895 £350 9 7			
Ditto, and sundry stockholders' capital account 45,429 16 1			
	45,780	5	8
	£48,052	10	6

Assets.	£	s.	d.
Capital account—amount expended for works	45,160	12	6
Stores on hand at December 31, 1895 : coal, £5 17s. 11d. ; oil, waste, etc., £20. 10s. 1d. ; general, £269 3s 7d.	295	11	7
Sundry debtors for current supplied to December 31, 1895, £2,579 8s. 3d. ; other debtors £16. 8s 2d.	2 596	6	5
	£48 052	10	6

REVENUE ACCOUNT.

Dr. A.—To Generation of Electricity.	£	s.	d.	£	s.	d.
Coal or other fuel, including dues, carriage, unloading storing, and all expenses of placing the same on the works	642	18	8			
Oil, waste, water, and engine-room stores	138	5	11			
*Wages at generating station	601	18	3			
Repairs and maintenance, as follows : buildings, £16 1s. 11d. ; engines and *boilers, £96 16s. 9d. ; machinery, instruments, and tools, £56. 4s. ; accumulators and accessories, £417. 11s. 5d.	586	14	1			
				1 969	16	11
B.—To Distribution of Electricity.						
Wages and other remuneration to linesmen, fitters, labourers	91	2	5			
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	67	11	5			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of materials and lamps sold	1	11	4			
Repairs, maintenance, and renewals of apparatus at distributing stations	0	15	7			
				161	0	9
E.—Rents, Rates, and Taxes.						
Rents payable	108	4	0			
Rates and taxes	36	1	3			
				144	5	3
F.—Management Expenses.						
Salaries (engineer's department)	365	17	8			
Printing and stationery	85	6	8			
General establishment charges	157	5	1			
				608	9	5
G.—To Law and Parliamentary Charges.						
Law expenses				1	4	10
H.—Special Charges.						
Insurance, etc.				20	7	4
				2,905	4	6
Amount carried to net revenue account				3,627	3	0
				£6 532	7	6

* Against these amounts a sum of £100. 3s 10d was received from the Yorkshire Boiler Insurance Company, as *per contra*.

Cr.	£	s.	d.
Sale of current per meter, 5d , 5½d., and 6½d. per B.T.U.	6,066	6	10
Rental of meters and other apparatus on consumers' premises	193	18	3
Other items—miscellaneous	66	10	7
Premiums and penalties	79	0	0
Stores on hand, December 31, 1894	26	8	0
Yorkshire Boiler Insurance Company	100	3	10
	£6,532	7	6

HANLEY ELECTRIC LIGHTING ACCOUNTS.

The accounts of the past year's working of the Hanley Corporation electric light station have just been issued. The loans sanctioned under the provisional order amount to £46,000, of which about £33,000 has been borrowed at 3 per cent., and of which £587. 18s. 10d. has been repaid.

CAPITAL ACCOUNT FOR YEAR ENDING DEC. 31, 1895.

Dr.	Expenditure up to Dec 31, 1894. £	s.	d.	Expended during year £	s.	d.
Value of lands appropriated for electrical purposes	500	0	0	—		
Buildings	3,951	8	8	2.104	18	8
Machinery	6 801	19	2	3.579	3	3
Mains, including cost of laying	6,845	10	8	3,012	2	5
Transformers, motors, etc.	1,160	7	2	1,531	6	5
Meters, and fees for certifying	599	5	5	329	18	11
Electrical instruments, etc	186	11	7	47	10	0
General stores (cable, mains, lamps)	537	16	10	94	8	11
Street arc lamps	870	18	0	—		
Stationery, printing, etc.	24	8	0	18	2	8
Clerk of works—salary	166	13	4	—		
	£21,644	18	10	£10,717	11	3
Total expenditure				£32,362	10	1

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Cr.	Receipts up to Dec. 31, 1894. £ s. d.	Received during year. £ s. d.
Amount raised by loans	21,000 0 0	1,110 0 0
Total receipts		22 110 0 0
Balance		10,252 10 1
		£32,362 10 1

REVENUE ACCOUNT FOR YEAR ENDING DEC. 31, 1895.

Dr.	£ s. d.	£ s. d.
A.—To Generation of Electricity.		
Coal or other fuel, including carriage, etc	£559 10 7	
Oil, waste, water, and engine-room stores	191 0 0	
Wages at generating station	467 1 1	
Repairs and maintenance, as follows—buildings, £7. 12s. 6d.; engines, boilers, £237. 15s. 1d.; dynamos, transformers, motors, etc., £37. 0s. 3d.; other machinery, instruments, and tools, £13. 17s. 7d	296 5 5	
		1,513 17 1
B.—To Distribution of Electricity.		
Repairs, maintenance and renewals of mains of all classes, including materials and laying same	4 3 5	
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	55 13 7	
Repairs, maintenance, and renewals of apparatus at distributing stations	2 11 5	
		62 8 5
C.—To Public Lamps.		
Attending and repairs	81 10 9	
Renewals of lamps	92 8 6	
		173 19 3
E.—To Rents, Rates, and Taxes.		
Rates and taxes		118 1 8
F.—To Management Expense		
Salaries, engineers' department	347 13 4	
Stationery and printing	14 19 6	
General establishment charges	34 17 8	
		397 10 6
H.—To Special Charges.		
Insurances, etc		15 12 6
Total expenditure		2,281 9 5
Amount carried to net revenue account		1 436 16 11
Balance carried to next account to provide for bad debts		5 17 2
		£3,724 3 6

Cr.	£ s d.
Balance from last account	31 16 8
Sale of current per meter at 6d. per B.T.U. less 5 per cent. £3,133 11 6	
Public lighting 484 3 0	
	3,617 14 6
Rental of meters and other apparatus on consumers' premises 74 1 10	
Sale and repairs of other apparatus 0 10 6	
	74 12 4
	£3,724 3 6

NET REVENUE ACCOUNT YEAR ENDING DEC. 31, 1895

Dr.	£ s. d.
Interest on mortgage debt accrued due to date	653 0 10
Interest on overdraft for extensions	101 8 0
Amount transferred to sinking fund	587 18 10
To balance carried forward	102 15 0
	£1,445 2 8

Cr.	£ s. d.
Balance brought from revenue account	1,436 16 11
Interest on money at deposit	8 5 9
	£1,445 2 8

GENERAL BALANCE-SHEET, DEC. 31, 1895.

Dr. Liabilities.	£ s d.
Capital account—amount received	22,110 0 0
Sundry creditors	176 5 4
Net revenue account—balance at credit thereof	102 15 0
Sinking fund account	587 18 10
Overdraft	10,252 10 1
Balance	612 2 11
	£33,841 12 2

Cr. Assets.	£ s. d.
Capital account—amount expended for works	32,362 10 1
Stores on hand December 31, 1895—coal, £23. 11s.; oil, waste, etc., £9; general, £53. 9s. 6d.	86 0 6
Sundry debtors for current supplied to Dec. 31, 1895	1,365 16 6
Other debtors	27 5 1
	£33,841 12 2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., YEAR ENDING DEC. 31, 1895.

Quantity generated in B.T. units	225,575
Quantity sold—Public lamps	45,716
Private consumers by meter	134 753
Total sold	180,469
Quantity used on Works, 3,309.	
otal quantity accounted for	183 778
Quantity not accounted for	41,797
Number of public lamps	33
Total maximum supply demanded in kilowatts	222

*30 arcs of 400 watts=375 8 c.p. lamps; three incandescent (various candle-power)=10 8 c.p. lamps.

LEGAL INTELLIGENCE.

ELECTRIC LAMP CASES.

Frazer v South.

In this case, tried on the 30th ult. in the Westminster County Court before his Honour Judge Lumley Smith Q.C., plaintiff, a dealer in electric appliances, carrying on business at Cecil court, Charing Cross-road, sued the defendant, Mr Harry South, an electrical engineer, of Garrick-street to recover the sum of £11 in respect of two electric lamps supplied to the order of the defendant in October last. The lamps were at first supplied on approbation, but the defendant kept them for six weeks, and after that time several applications were made for payment, but he took no notice, and the action was brought.

Mr. Wm. Adam Frazer was called, and said the goods were supplied to the defendant's manager on approbation As he did not return them within a reasonable time, an invoice was sent in in due course, but he took not the slightest notice of it

The defence was that the goods were never ordered by the defendant, but were simply ordered on approbation at the instance of Mr. Vernon Dowset, manager of the Tivoli Music Hall, on whose behalf defendant was acting.

Mr. Vernon Dowset was called, and said the defendant had the contract for supplying electric light at the Tivoli and at the request of the plaintiff he (witness) authorised him to try two of the lamps in question They were not found to be successful, however, and witness was under the impression that they had been returned.

The **Defendant** said that what he did in the matter was purely at the instigation of Mr. Dowset, and he never in any way made himself personally liable for payment of the plaintiff's claim.

His **Honour** said that if the defendant did not intend to be liable for payment he should have made it clear to the plaintiff. He had failed to do so, however, and judgment would be for the amount of the claim, with costs.

Francis v. Spilsbury.

This case was heard in the same court on the following day. The plaintiffs are electrical engineers carrying on business at Victoria street, Westminster, and they sued the defendants, who are dealers in electrical appliances, to recover the sum of £6 odd, which sum, it was alleged, had been over-paid in respect of a large number of Swan Edison lamps supplied. The plaintiffs' case was that they were engaged in installing the electric light at a London hospital, and for the purpose of carrying out the work they ordered several hundreds of lamps of various kinds from the defendants, who are agents for the Edison and Swan Company. The goods were duly delivered packed in a case, but upon their being unpacked it was found that there was a large number of lamps deficient. The defendants were acquainted of the fact, but in the meantime they pressed for payment of their account, and by an oversight a cheque was sent to them for the full amount. Subsequently several applications were made to them to complete the order, but they declined to recognise the fact that they had sent 75 lamps short, and consequently the plaintiffs had to go and purchase more lamps direct from Messrs Edison and Swan, with the result that so far as the 75 lamps in dispute were concerned they had been paid for twice over.

Mr. O'Brien was called, and said he was the engineer to the plaintiff firm, and had the work in question under his charge. In July last year he ordered several hundred lamps from the defendant firm, but upon their being unpacked it was found that there were 75 short. The defendants refused to make good the mistake, and consequently the plaintiffs had to go to Edisons and purchase more, and inasmuch as the defendants had been paid the full amount of their bill, the plaintiffs had had to pay twice over for the 75 lamps which were deficient.

The **Defendant** was called and said his firm were agents for the Edison and Swan Company, and upon receiving plaintiffs' order it was sent on to that firm to execute. He had made enquiries of Messrs. Edison and Swan, and had been assured by them that the goods were properly packed, and that the right number of lamps were enclosed in the case.

The packer and checker from Messrs Edison and Swan's firm were called, and both swore positively that when the case left their firm's premises it contained the proper number of lamps.

In giving judgment, his **Honour** said the facts of the case according to the evidence were very difficult to deal with, but on the

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whole he thought that it was quite consistent to assume that the mistake in the packing arose on the premises of Messrs. Edison and Swan. The judgment, therefore, would be for the plaintiffs for the amount claimed, with costs.

COMPANIES' MEETINGS AND REPORTS.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Tuesday at the Carnaby-street central station, Golden-square. Mr. Eustace A. Balfour presided.

The annual report and statement of accounts were taken as read.

The **Chairman** said that before formally proposing the adoption of the report and accounts there were two or three observations he should like to make, chiefly in reference to the working of the Company since last the directors had the pleasure of meeting the shareholders. He thought they might fairly congratulate themselves on the result of the year's working. The Board proposed a dividend of 7¼ per cent. on the ordinary shares, as against 6½ per cent. last year and 4½ per cent. the year before that. He was glad to say that the hope he expressed last year, that there would be something to divide among the founders' shareholders, had been fulfilled. They proposed a dividend on the founders' shares of £2. 19s. 6d. per share. During the past year the number of lamps connected had been increased by 22 per cent., but what was still more satisfactory was the progress of their business during the present year. Since January 1 they had had applications for no less than 6,000 lamps, and in addition to that they had actually increased their gross revenue during the first four weeks of 1896 by £1,200. The actions instituted against the Company alleging nuisance from the plant at Mason's-yard station had been arranged, but the directors had arrived at the conclusion that it would be necessary to charge the whole of the expenses incurred and the cost of refitting the engines in use at the station to the revenue. That had been delayed as long as possible with a view of determining the best method of overcoming the difficulty and trouble. Unfortunately, no definite conclusion could be come to in time to avoid legal action in the matter, but the directors were fully satisfied that the fault was to be found in the engine itself, and that the engines must not vibrate During the last half-year more than half the engines had been sold at a considerable loss, but being satisfied with the new engines which had been put in, the directors had decided to sell the whole of the old engines, and so refit the whole of the machinery at Mason's-yard station. They expected that this would incur a further loss of about £1,500. At the same time, steps had also been taken at both the Company's stations to stop all possible complaint due to the emission of smoke or dust from the chimneys, and they felt confident of being able in future to carry on their business without causing any annoyance to their neighbours. In November a further issue of £20,000 of debenture stock was made to the shareholders, and was considerably over-subscribed for. The directors did not anticipate, unless unforeseen events occurred, that there would be any necessity for raising further capital during the present year. They expected to have an order from the parish of St. James to light the principal thoroughfares in the district, and they were quite prepared to light it. Last year they were able to announce that the cost of working had been reduced by ¾d. a unit, and great credit was due to the staff for having still further reduced the cost by ¼d. a unit. The directors had made efforts to come to an arrangement with the founders' shareholders, but unfortunately the offer made by the Board, subject, of course, to the approval of the ordinary shareholders, had not been unanimously accepted, and therefore the negotiations fell to the ground The Chairman announced that his brother, Mr. Gerald Balfour, M.P., had ceased to be a director, as, on his appointment as Irish Secretary, he did not feel himself justified in retaining his seat at the Board. In conclusion, he thanked the staff, especially Mr. Walker (general manager and secretary) and Mr. Dobson (chief engineer), for the zeal and ability they had shown in the Company's interests, and formally moved the adoption of the report and accounts.

Mr. Latimer Clark, vice-chairman, seconded the motion.

A **Shareholder** said he had hoped some arrangement would be come to with the holders of founders' shares. Did he understand that those holders were above price?

Mr. Fry said he took a most prominent position in trying to negotiate this matter, but he regretted to say their endeavours came to nothing. The proposal which emanated from the Board he considered most fair and reasonable, and if the Board had gone further in the matter he felt convinced that the ordinary shareholders would not have consented to greater terms. The holders of founders' shares, of course, had their rights, but he thought that in the interests of the Company it was essential that those shares should be done away with. The directors' hands would then be unfettered, and he strongly urged, even if a large price had to be paid, that some arrangement should be come to.

Dr. Ware thought the founders' shares were a millstone round the Company's neck, and he would be glad to see them paid off, of course, not at an exorbitant rate, but he would say even at an extravagant price.

The **Chairman** said he was entirely in sympathy with the desire to come to an arrangement with the founders' shareholders, but there was a point beyond which the shareholders, of course, would not go. In their offer the Board reached the very utmost limit they could possibly advise the shareholders to accept, and that being so they arrived at the end of the matter; but the offer was, of course, still open. The articles of association required that the offer must be accepted by the whole of the holders of founders' shares—there must not even be a minority of one; and as for the suggestion that they should alter the articles of association, that required as much unanimity among the founders' shareholders as the offer did. It was unfortunate, but it was so. In reply to questions, the Chairman said the terms proposed were the allotment of 80 ordinary shares at par for each founder's share. At the time the offer was made it was equivalent to £280 per founder's share, and at the present market value it would have been something like £400.

A **Shareholder** said he thought that was an extremely low offer; he thought they might offer considerably more than that.

The report was adopted.

Mr. Bennett Fitch, M.I.C.E., and Mr. Walter Leaf were re-elected directors; and Messrs. Deloitte, Dever, Griffiths, and Co. were re-elected auditors.

A vote of thanks to the chairman concluded the meeting.

GIANT'S CAUSEWAY AND PORTRUSH ELECTRIC TRAMWAY.

The annual report of the directors of this Company says: Your directors have to report a considerable increase in the receipts during the past year as compared with those of the year 1894. In the passenger traffic there has been an increase in the number of first-class passengers to the extent of 931, and an increase of 4,768 in the number of ordinary passengers, making a total of 99,616 compared with 93,917 in 1894. The receipts have consequently risen from £2,873. 13s. 11d. in 1894 to £3,107. 9s. 5d. in the past year. The goods and mineral traffic rose from 26 to 42 tons, while the corresponding receipts have risen from £12 5s. 1d. to £14. 8s. 7d. during the year; the miscellaneous receipts and those for parcels from £28. 7s. 5d. to £33. 18s. 6d.; so that the total receipts from the revenue account have been £3,156. 1s. 6d. as against £2,914. 6s. 5d. in 1894. On the other hand, there has been a considerable increase on the expenditure side of the account, which shows a total of £2,426. 5s. 2d., as against £2,189. 8s. 3d. in 1894. There is, however, a credit balance on the result of the year's working of £729. 16s. 4d., as against £724 18s. in 1894. The large expenditure on revenue account has been caused by a lawsuit in which the Company were engaged, and which could scarcely have been avoided without appearing to give a tacit consent to the establishment of a public right of way along a portion of the railway part of the line. A defendant was fined by the Bushmills bench of magistrates for a trespass on one portion of the railway, and on the same occasion he was prosecuted for an exactly similar trespass on another portion of the railway, when suddenly the question of a claim to a public right of way, not across, but along the line, was raised by a member of the bench, though the defendant had not put in an appearance, and was not represented, and the case was dismissed. Your directors sought to set this decision aside in the Queen's Bench, but they were defeated on the technical ground that a defendant could not be tried twice for a criminal offence, so that the real merits of the case, so far as they involved the question of a public right of way, were not tried at all, and it affords a remarkable travesty of the administration of justice in Ireland that it took four judges, four Queen's counsel, and two junior counsel, occupied for two days, with any amount of affidavits, to decide whether a trespassing pauper should or should not have been fined 2s. 6d., involving, as it did, a cost of over £260, of which the Company were required to pay £229 3s. 3d. Another large item in the expenditure of the year is that for "compensation"—£159. 1s. The greater of this was an instalment payable to the injured lady referred to in our last two reports, and £50 were paid for the funeral and other expenses connected with the death and removal to England of the unfortunate cyclist who got killed on the line through his own carelessness Your directors thought it better to be liberal in regard to this matter, but they steadily refused to acknowledge any liability in the way of damages, though at first threatened with an action. One more instalment of £100 remains due to be paid out of the income of the ensuing year to the aforesaid lady, and your directors hope that in future items under the heads "law costs" and "compensation" will disappear from their accounts, if they have again the good fortune in these respects which they enjoyed for so many previous years. The item for "maintenance of way and works" appears large—£290. 13s. 11d., as against £225. 6s. 4d. in 1894, and £178. 9s. 11d. in 1893. This has arisen from the necessity of making two new sidings, or passing places, on the line, and lengthening some of the others, so as to meet the rapidly increasing traffic, the number of passengers during the past year having risen to within 400 of 100,000. In spite of all the misfortunes enumerated above, the net balance to credit on the year's working has increased from £724. 18s. 2d. to £729. 16s. 4d., as already stated. Your directors have, therefore, every confidence in the future of the line, though they are still unable to give the shareholders any immediate benefit. One result, however, of the unfortunate accident above referred to has been that the Board of Trade, after an enquiry held in Portrush by Major Cardew, R.E., on their behalf, have required the Company to adopt the overhead system of electric current, instead of that by the present conductor rail, which is only 18in. above the ground. Your directors roughly estimate the cost of this change at £5,000, but the available electrical power

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will be considerably increased. It is rather an anomalous state of affairs in Ireland that every facility for light railways, either by cheap money or by absolute gifts from the English Exchequer, should be given to those parts of Ireland which do nothing for themselves, and that interest at 4 per cent. should continue to be charged for loans in the North of Ireland, where private enterprise has done so much, and with so little return. It must be borne in mind that your line from Portrush to the Giant's Causeway has not only opened up the whole district, and developed the tourist traffic to that far famed region, but that it affords one of the best and cheapest outlets for the enjoyment and recreation of the working classes of Belfast and the other commercial towns in the North of Ireland. Under all the varying and untoward circumstances of the Company the interest of £400 a year has been regularly paid to the Board of Works, and even £225 of capital paid off to them, out of revenue, and your directors entertain the hope that the Government and the Treasury will advance sufficient additional capital at a lower rate of interest than that heretofore paid to enable the Company to carry out the requirements of the Board of Trade The number of miles run by steam power during the year has increased from 10,487 to 14 829, the cost being 10½d per mile: those run by electrical power have been reduced from 20,643 to 17,323, at a cost of 4d. per mile. The total number of miles run has increased from 31,130 to 32,152, and the cheapness of electricity as a locomotive power is still apparent.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY.

The ordinary general meeting of this Company was held on Tuesday at Leeds, Mr. Grosvenor Talbot presiding.

In moving the adoption of the report, a copy of which appeared in our last week's issue, the **Chairman** said the profit available for dividend from last year's trading amounted to £6,321, and they brought forward from last year's account £162 making a total of £6,483 to be dealt with. In July last they declared an interim dividend at the rate of 4 per cent. per annum, which took exactly £1,000. The directors now recommended a dividend at the rate of 6 per cent per annum for the half-year just ended, making 5 per cent. for the whole year. That required £1,665. 7s 7d. The directors also recommended that they should carry to the reserve fund for depreciation and other purposes the sum of £3,300, leaving a balance to carry forward of £517. 16s. 4d. The directors felt that this year, as well as a dividend at the rate of 5 per cent. per annum, they had been able to offer considerable advantages to the shareholders in the shape of new shares which had been allotted. All shareholders had as many new shares offered them at par as the number they then held, and as the £5 shares were now selling at £7 to £7. 7s., and those on which £1 had been paid were selling at £2 7s. 6d, they felt that that was equivalent to a very handsome bonus. They also felt that it was very desirable that they should accumulate a considerable reserve fund for depreciation and other purposes. Up to the present time they had no reason to regret a single step that they had taken in the erection of the plant and machinery, but there were possibilities in electrical science which they must always bear in mind, and which possibly might render advisable expensive alterations that they would more willingly entertain if they had in hand a considerable reserve Last year the business had been satisfactory. The total receipts had been £11.431, as compared with £7,457 in the previous year; and their expenses had been £4,617, as against £3,747 in 1894. The net profit was £6,780, as compared with £3,709 in 1894 Thus, the total revenue had increased by 57 per cent, and the expenses had only increased by 25 per cent., leaving a net profit of 82 per cent. more The cost of coal had been only £670 for the year, and had beaten the record per unit of any station in the United Kingdom. Since the report was issued the directors had signed an agreement for the purchase of the Britannia Mills, adjoining their offices, as they felt that the possession of such a property would be of enormous value to them in the future. For some years the property would remain in its present condition, but when it was necessary to make extensions the work could carried on more economically than on a new site, and a very expensive and complicated rearrangement of the system would be avoided. The premises in question were well let, and it would not be necessary to disturb the tenants; and after paying the interest on the purchase money a satisfactory balance would remain to the credit of the property. Proceeding to refer to the popularity of the system of lighting by electricity, Mr. Talbot remarked that there was now a sum of over £8 000,000 invested in electric light companies. When the Leeds company started supplying the current in 1893 there were 35 towns in the provinces using the light, and now there were 89. As to the question of new plant, he observed that the directors had ordered two vertical engines of 500 h.p., each running at 355 revolutions, with direct-coupled alternators. This involved to a certain extent a new departure, as there was no station in England where a plant was in existence similar in every way to what they required in Leeds, and running under such stringent conditions. The directors had, however, obtained such guarantees and assurances as satisfied them that the requirements would be carried out in their entirety; the new engines and alternators would run in parallel with the old plant, also by themselves alone when needed, and the whole plant would be practically noiseless.

Mr. A. G. Lupton seconded the motion, and it was carried, as were formal resolutions for the dividend and re-election of retiring directors, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Parma (Italy).—The municipal authorities of the city of Parma desire tenders by February 25 for the electric lighting of the city from June, 1897, to 1912.

Beziers.—Offers are wanted by February 15 for a concession for an electric tramway, about 8,800 metres (5½ miles) long. Particulars at the Mairie, Beziers, France.

Manuel.—Offers are wanted for the electric lighting of the town of Manuel, in the province of Valencia, Spain, for 15 years. Number of inhabitants, 1,500. Price suggested, 1,500 pesetas, payable monthly.

Belper.—The gas company are considering the setting up of an electric lighting plant, and electrical contractors can obtain information as to it on application to the Managing Director, Gas Company's Offices, Belper.

Teneriffe (Canary Islands).—Tenders are invited for the electric lighting of the town of Santa Cruz, Teneriffe, for a period of 35 years. Particulars can be obtained at the Ministerio de la Gobernacion, Madrid, and tenders must be delivered by February 29.

Brunn (Austria).—The Municipality desire offers for the construction and working of a central station for the supply of electric energy for lighting the town, for power, and, if required, for running a tramway. Tenders must be sent before March 31 to the Bürgermeister, Brünn, Austria, from whom particulars can be obtained.

Harrogate.—Tenders are invited for the various works required in the erection of electricity generating station on the Corporation farm, near Harrogate, for the Corporation. Plans and specifications may be seen and quantities obtained. Tenders are to be submitted by 10 a m. on 10th inst Mr. Samuel Stead, borough surveyor, Municipal Offices, Harrogate.

Brussels.—The Belgian State Railways are offering for tender the work necessary for the alteration of the conductors and wiring for the electric lighting of the Marbehan Station. The contract is part of a rearrangement of the water supply, and particulars are obtainable at the Bureau du Chef du Service, Arlon, Rue de la Station, 26 Tenders must be in by February 20.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grangetown, Yorkshire, to whom the plans, etc., must be sent by May 1.

Rochdale.—The Paving Committee invite tenders for electric lighting plant required at the sewage works, Roch Mills. Plans may be seen, and specification and form of tender obtained, at the office of the borough surveyor, on payment of a deposit of £2, which will be refunded on the return of the documents and the receipt of a bona fide tender. Tenders, under cover, endorsed "Sewage Works Electric Lighting," must be delivered at the office of Mr. James Leach, deputy town clerk, Town Hall, Rochdale by noon on 12th inst.

Croydon.—Tenders are required for the erection of a chimney shaft and buildings to receive machinery for electric lighting proposed to be built in Factory-lane, Croydon, for the Corporation. The drawings, specification, and form of contract, prepared by Prof. Kennedy, F.R.S, may be seen at the borough engineer's office, 8, Katharine-street, Croydon, and bills of quantities, form of tender, and other particulars may be obtained on payment of £5, which will be returned to every person sending in a bona fide tender. Tenders to be sent to Mr. Saml Jacobs assistant town clerk, Municipal Offices, 8, Park-street, Croydon, by 11 a.m. on 14th inst., endorsed "Tender for Electric Lighting Buildings."

London, N.W.—The Vestry of St. John, Hampstead, invite tenders for the following, among other works and materials, for one or three years, at the option of the Vestry, from March 26: (17) coal and coke (including coal for electric lighting station); (23) oils for machinery at electric lighting station; (24) tools, implements, and other electrical engineers' stores; (25) carbons, lamps, and other stores for electric lighting station; (30) removing ashes from electric lighting station. Forms of tender may be had, and further particulars obtained, on application to the surveyor of the Vestry, Vestry Hall. Tenders, endorsed "Tender for ——" (as the case may be), are to be delivered to Mr. Arthur P. Johnson, vestry clerk, Vestry Hall, Hampstead, by 4 p.m. on February 12 No tender for items numbered 1 to 25 inclusive will be received unless the same be accompanied by £10 in cash or bank-notes (not to be enclosed) as an evidence that the tender is made bona fide, and the amount will be returned to each person whose tender is not accepted, but will be retained in the other case until the contract (and bond, if necessary) are duly signed. Each contractor will be required to enter into a written contract, and, with respect to certain contracts, to provide two good and sufficient sureties in such a sum as the Vestry may determine for the performance of contract. The expenses of preparing and stamping contracts (and bond where necessary) to be paid by the contractor.

RESULTS OF TENDERS.

Glasgow.—The India Rubber, Gutta Percha, and Telegraph Works Company, Limited, 8, Buchanan-street, Glasgow, have secured the contract for a complete installation of electrical machinery for the Glasgow Subway Company, Limited. The

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contract includes four large high-speed engines and dynamos, 13 electric pumps, the lighting of 15 stations and trains, and the supply of power for the elevators.

Burriana.—For the electric lighting of Burriana for 9,000 pesetas a year there were two applications—viz., Señores Vincente Peyrats Rios and Leopoldo Davalos. The decision was adjourned.

BUSINESS NOTES.

Great Northern Telegraph Company.—For the month of January the receipts were £22,400.

Windsor.—Windsor Castle is being placed in direct telephonic communication with the Metropolis

Southwark (London).—It is proposed to light St. George's (Roman Catholic) Cathedral by electricity.

Islington.—The Lord Mayor has fixed Wednesday, March 4, as the day on which he will open the new electrical station.

Eastern Telegraph Company.—The receipts for the month of January were £78 886, as against £70,674 for the corresponding period of 1895.

Stafford.—The County Council Committee have presented an estimate and recommendation for the electric lighting of the judges' lodgings.

Brisbane.—The existing city tramways have been purchased by a London syndicate, which is converting them into an overhead electrical system.

Barmouth.—The District Council have passed a resolution approving of an application by a local company for permission to light the town with electricity.

Eccles.—The Town Council have resolved to take steps to test public opinion in the borough with regard to the advisableness of lighting the streets by electricity.

Eastern Extension Telegraph Company.—For the month of January the receipts show an increase of £8,738 as compared with the corresponding period of 1895.

Llandudno.—The District Council have engaged Mr. A H. Preece at a fee of 50 guineas to report upon the best scheme for lighting the town by electricity

Hove (Brighton).—The fire brigade are about to memorialise the Urban District Council, asking them to take such steps as are necessary to establish electric fire-alarms for the protection of the town.

Tobermory (Mull).—A scheme has been planned for lighting Tobermory, the capital of Mull, by electricity Aros Falls are proposed as the motive power, and £1,000 of capital is considered adequate.

Address.—Mr. P Speedy, formerly assistant engineer to Mr. A. H. Wood, A I.E.E, 39, Victoria-street, S.W., has set up in business as an electrical engineer and contractor at 55, Victoria-street, S.W.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending February 2 amounted to £1,044 as compared with £924 in the corresponding week of the previous year being an increase of £120

Ayr.—The transformers having proved somewhat unsatisfactory, they are to be sent back to London and new ones put in their place. The street lamps have been meanwhile supplied from the low-tension cable instead of from the high-tension wires.

New Company.—The Electrical Appliances Syndicate. Limited, has been registered with a capital of £2,000 in £1 shares. Objects: to acquire any patents, inventions, etc., relating to improvements in electrical appliances, and to develop and work the same

Llanelly.—The Borough Council have decided to ask Mr. Howell to give an estimate of the cost of wiring the town hall, the Athenæum, the market, and several of the leading thoroughfares, and what the annual cost might be expected to be, say, for 10 years.

New Telegraph Cable to Germany.—The Post Office authorities have under consideration the laying of a new cable between this country and Germany to supplement the lines now in use, and thereby to accommodate the increasing traffic between London and Berlin.

Canterbury.—The report of Mr. Robert Hammond, M.I E.E., to whom the Town Council applied for advice regarding the proposal to introduce the electric light into Canterbury, has been received and printed, and was this week issued to the members of the Council.

Harrogate.—A cable for the public and private supply of the electric light has been laid in James street, and the motive power for the generators will be derived from refuse destructors which are intended to be erected on the property of the Corporation at the irrigation farm.

Wilmslow.—At a meeting of the District Council Mr Ross tried to reopen the question of electric lighting by moving that a former resolution postponing the discussion of the question until June be rescinded. After discussion, however, the motion was lost by five votes to four.

Lambeth (London).—The committee of the London County Council have approved the plans submitted on behalf of the Charing Cross and Strand Electricity Supply Corporation, Limited, for the construction of a generating station, iron coal-bunkers, and furnace chimney shaft at 85, Commercial-road.

City and South London Railway.—The returns for the week ended February 2 were £991, compared with £1,021 for the corresponding period of last year, being a decrease of £30. The total receipts for the half year terminating as above were £5,026, compared with £5,020 in the same period of the preceding year, being an increase of £6

Sheffield.—The Parliamentary Committee of the Corporation have been informed that the Sheffield, District, and Rotherham Tramways Company, who proposed to take over the tramway system in Sheffield, had decided to withdraw their Bill from Parliament for this session. The committee decided to enter into negotiations with the company now owning the tramway system.

Cardiff.—Mr. H. J. Hallett, the expert appointed by the Lighting Committee, has commenced his enquiry into the circumstances which led to the suspension by the manager (Mr. Appleby) of one of the assistant engineers employed in the electrical works. The enquiry was private, and, after hearing the statements on both sides, Mr. Hallett decided to visit the works and inspect the machinery.

Birmingham.—The Town Council have given formal sanction to the Central Tramways Company to substitute the electric overhead wire system for the horse traction upon the tramways leased by the committee to the company between Albert-street and Nechells Park-road, upon conditions set out in the Works Committee's report, or such modifications thereof as the committee may think necessary or advisable.

Paisley.—A fire occurred on Monday at Blackstoun Mineral Pit, near Paisley, the property of Messrs. Wm. Black and Sons, Limited. The outbreak originated in the electric machine-house, and afterwards spread to the engine-house. The latter building was entirely destroyed as was also the electric apparatus in the machine house. The total damage caused is estimated at about £1,000, which is understood to be covered by insurance.

Kidderminster.—A special meeting of the Town Council has been held to consider the question of the proposed electric tramway from Kidderminster to Stourport. The General Purposes Committee presented a report relative to the tramway scheme, and it was recommended that the Council, subject to some modification in the plans which the promoters of the Bill had agreed to make should approve of the Bill. The report was adopted.

Dover—At the last meeting of the Town Council, the clerk read a letter from the electric lighting company. asking that the acceptance of the contract with the gas company for the lighting of the whole of streets by incandescent burners might be deferred, at any rate so far as it concerned the streets in which their cables were laid for a fortnight or so, as they intended to submit an alternative scheme for lighting the streets by electric light at a less cost. The matter was deferred.

Edison and Swan United Electric Light Company, Limited.—The directors have resolved that a payment on account of the dividend of the current year be made at the rate of 5 per cent. per annum, less income-tax, on the A shares of the Company in respect of the half-year ended December 31, 1895. This will work out as follows: on the 89 261 partly-paid £5 shares, £3 paid, 1s 6d. per share; on the 17,139 fully-paid £5 shares 2s. 6d. per share. The dividend warrants will be issued on the 18th inst.

Electric Traction in Germany.—It has just been announced, at a meeting of Mayence merchants, that the South German Railway Company of Darmstadt, are going to work the tramways of Mayence and its suburbs by electricity. The same company are also seeking authority to construct and equip electric lines uniting Mayence, Biebrich, and Wiesbaden; Kastal Erbenheim, Nordenstadt, Delkenheim Wicker, and Hockheim-on-the-Main; and Mayence Laubenheim, Bodenheim, Nachenheim, Nierstein, and Oppenheim.

Extraordinary Development of Business.—During the month of January Messrs Siemens Bros. and Co. Limited, of 12, Queen Anne's-gate, London S W. received no less than 38 orders for machines having a total output of 4,200 kilowatts and with a horse power of about 5,700. Of these machines, 15 are for outputs of more than 200 kilowatts each These figures give some idea of the enormous amount of business that Messrs. Siemens are doing. and are an eloquent testimony to the high standard of their workmanship.

Pembroke.—A public meeting of ratepayers will be convened shortly to protest against the Corporation entering into any agreement with a syndicate, which is in course of formation, for the purpose of lighting the streets of Pembroke by electricity. The syndicate is understood to consist of local men, some of whom are members of the Corporation, and they expect to realise a profit of at least 25 per cent. The opponents of the proposal will advocate the desirability of the Corporation taking the lighting of the streets into their own hands.

National Telephone Company.—The directors have resolved, subject to final audit, to recommend the following dividends for the half year ending December 31: At the rate of 6 per cent. per annum, less income tax, on the amounts paid up on the first and second preference shares; at the rate of 5 per cent. per annum, less tax, on the amounts paid up on the third preference shares; at the rate of 6 per cent. per annum, free of tax, on the amounts paid up on the ordinary shares; carrying £35,000 to reserve and about £5,000 forward.

Cork.—The Town Council have decided to engage Mr E. Manville. of the firm of Messrs. Kincaid, Waller, and Manville, electrical engineers, to report, at a cost of £42, upon a suitable site for works and scheme for lighting the city by electricity, and with estimate of capital, cost of maintenance, and revenue. Mr.

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Manville is also to report on the results of the working of other stations, so as to enable the Corporation to judge whether ir would be advisable for them to undertake the work themselves, ot to lease the provisional order now applied for to a private company

Pitlochry (Perthshire).—Prof. Forbes has submitted to the directors of the gas company a report and detailed estimate of the cost of the proposed scheme for introducing the electric light into Pitlochry. Prof. Forbes estimates that £4,000 would carry out the scheme, which provides for 3,000 lights of 16 c.p. or their equivalent, and states that if the light were fully used a charge equal to a rate of 2s. 6d. per 1,000 cubic feet of gas would yield a profit. Further consideration of the scheme was deferred until the precise terms on which the water power could be had are ascertained.

Fareham.—Mr. Chennell, Q C., having applied to the Queen's Bench on behalf of the Urban District Council for a further stay of execution of the judgment given in December last in favour of the Fareham Electric Light Company, Limited, Mr. Robson, who appeared for the company, consented to a stay for 14 days, intimating that his clients were willing to take interest at the rate of 4 per cent. on the amount of the contract. An order was accordingly made for a stay of 14 days. It is stated that the Local Government Board are willing to grant the Urban District Council permission to borrow the sum of money asked for in their first application, but that any other amount would require further consideration.

Chelmsford.—A letter was read at the last meeting of the Town Council from Messrs Crompton and Co., stating that if the Council favoured the idea they would be happy to forward the price they were prepared to accept for the new generating premises now in course of erection and the whole of the town-lighting plant. Messrs. Crompton further pointed out that the firm contemplated putting up other large works on a fresh site Naturally, these premises would be a benefit and improvement to Chelmsford in two ways, as the money received for the town lighting would be utilised for additional extension and the extra employment of labour. The letter was referred to the Lighting Committee, with instructions to fully investigate the matter and report thereon.

Appointments Open.—The Corporation of Edinburgh invite applications from gentlemen who have had a thorough training both as mechanical and electrical engineers for the post of resident engineer for the central electric light station. It is most desirable that candidates should have had practical experience in central-station working, and also if possible, in the laying of electric mains. Salary £400 per annum. A schedule of duties will be sent by the town clerk on application. All applications should be in the hands of Mr. Thomas Hunter, W.S , town clerk, City Chambers, Edinburgh, before the 17th inst.—We also publish particulars in our advertisement columns of a post as electrical engineer of some works in the country at a salary of £250 a year, with a percentage of the profits.

Leicester.—The Mayor announced at the Council meeting that he had received a letter from a gentleman named Hobbs, who resided on the South Coast of England, and who was trying to induce the Government to undertake the work of effecting telegraphic communication between lightships and the shore. Sir Israel Hart moved that the letter be referred to a committee for consideration, and said all who were interested in maritime matters knew the desirability of electric communication being established between lightships and the mainland. Mr. Hobbs had succeeded in doing it in the case of 50 out of the 250 stations round the coast, and his object was now to bring the question before Parliament with a view to inducing them to undertake the remainder of the work. Councillor Rowlett seconded and the motion was agreed to.

Douglas (Isle of Man).—The movement in favour of lighting the promenade and the principal streets by electricity seems likely to result in the installation of the electric light before next season. The only question to those who support electric lighting is whether it should be entrusted to a company who have tendered to light the front for £1,400 a year, or whether the light should be produced by the Corporation. The consensus of opinion is in favour of the latter. but it is doubtful whether the town would provide its own light, seeing that the initial cost would be about £44,000. A voluminous correspondence has been going on in the local Press on the subject between Mr. E. Berry and Mr. G. Gillmore, the former of whom advocates that if the town is to be lighted with electricity, the Corporation should do the work and take what profit there may be

Glasgow.—The accounts of the Corporation electric lighting department for the year ended December 31 last show that the revenue amounted to £3 611. 8s. 9d., and the expenditure to £1,356. 18s., leaving a balance to be carried to the revenue account of £2,254. 10s. 9d It is expected that the Council will reduce the price of the electric light by a penny per unit. A deputation from the Public Electric Lighting Committee has visited Edinburgh for the purpose of inspecting the electrical installation in the city. They were received by Councillor Mackenzie, convener, and several members of the Edinburgh Electric Light Committee. by whom they were shown over the station at Dewar place Subsequently they were entertained to dinner in the Rutland Hotel, under the presidency of the convener of the Edinburgh Electrical Committee

Derby.—The Electric Lighting Committee estimate that on account of the increasing demand for light it will be necessary to lay a heavy concentric cable in the place of the five pairs of small cables, at a cost of £3,430. Their other estimates are as follow: extension of high-tension feeder mains for Babington-lane, for lighting the technical college, £175; new transformer-chamber for the technical college, £55. 10s.; two 60-kilowatt transformers at £140 each, £280; electric lighting of Babington-lane by placing incandescent lamps in existing gas lamps, £170; six large low-tension switches at £5 each, for extra transformers, £30; estimated cost of making house service connections. including borough surveyor's charges, £310; cost of meters, £250; side tip wagons etc., £17. 10s.; one 1-h.p. motor, worm, and drum, for hauling coal, etc., out of coal-store, £50; sundries, such as holders, switches, lamps, and small cables, £77. 11s.; lathe, £50; service connections to March 31, 1896. £50.

Dublin.—A numerous deputation from the Ratepayers' Association waited on the Council at their last quarterly meeting with reference to the question of the extension of tramways in the city. Mr. Field M P., said that he was there in the interests of an opponent of monopoly, and spoke in an independent position. The classification of signatures to the memorial, it was important to say, included 17 public companies, 131 professional men, 86 merchants, 786 traders, 1,107 owners, lessees, and occupiers, and the total signatures were 5,153. There were 1,400 frontages in the routes traversed by the proposed extension, and not one objection from them had been lodged against the proposed southern tramways, but, on the other hand, nearly the whole number signed the memorial in favour of the Bill. He believed that the electric tram system had come to stay, and there was no amount of opposition that would succeed against it Several other gentlemen also spoke in favour of the Corporation Bill.

Ripon.—At the quarterly meeting of the City Council, the Mayor (the Marquis of Ripon, K G) stated that the Dean and Chapter had agreed to postpone for further consideration the question of lighting the cathedral with the electric light until their July Chapter meeting. They expected then to hear from the Corporation any offer they might have to make, and if accepted it would be with a view to the minster being lighted by October 1. That left the Corporation in the position of having made no offer, and stated no terms to the Dean and Chapter, and of having until their June meeting to carefully consider what steps to take in regard to the question of electric lighting. He was very glad that was the case, and he ventured to recommend that the Gas Committee should take the whole subject into their further and careful consideration, not merely the question of lighting the minster or any other particular section of the city but the whole question of electric lighting in the city, under the circumstances in which they now found themselves. He moved the adoption of the whole of the minutes of the Gas Committee, which were confirmed.

The Waterloo and City Railway.—The work in connection with this railway is being rapidly pushed forward, and considerably more than half the tunnelling work is finished. The line will be about a mile and a-half long, and already communication is completed between a point below the Cannon-street end of Queen Victoria street and another point below Stamford-street. and near the Waterloo-road. The station at Waterloo will be built among the arches underneath the existing South-Western Railway station, while the City station will be at the Mansion House end of Queen Victoria-street The whole of the ground beneath the Mansion House and Royal Exchange-square will be excavated. as the Central London Railway will have its station here. A ring tunnel is to be constructed just beneath the surface of the existing roadways and will communicate with the pavement by five stairways. The railway platforms will be about 58ft below the subways, and they will be connected with the offices by hydraulic lifts. A branch subway will lead to the station under Queen Victoria-street. and all these subways will be open to the public.

Sir Wm. Armstrong and Co., Limited.—The new Company has been registered with a capital of £4,000,000 divided into 200,000 4 per cent cumulative preference shares of £5 each and 3,000,000 £1 ordinary shares, to adopt and carry into effect the agreement expressed to be made between Sir W. G. Armstrong, Mitchell, and Co , Limited (incorporated 1882), and the Company, for the acquisition as a going concern of the business. The first directors are the Right Hon. Lord Armstrong, Sir A. Noble K.C.B., Admiral the Count Albini, William D. Cruddas, Colonel Henry C. S Dyer, Hon. E F. L. Gower, S W. A Noble, George W. Rendel Hamilton O. Rendel Right Hon. Lord Rendel, Henry F Swan, Josiah Vavasseur, Philip Watts, Percy G. B. Westmacott, and Lieut.-Gen. Charles W. Younghusband, C B. An extraordinary meeting of the shareholders of Armstrong, Mitchell, and Co. has been held in Newcastle for the purpose of taking final steps in the reconstruction scheme. Lord Armstrong, who presided, said it was only necessary to confirm the resolutions previously passed relative to the reconstruction, and the resolutions were confirmed accordingly.

Edinburgh.—The Plans and Works Committee of the Town Council have recommended that the police cells should be lighted by electricity. They have given Messrs Siemens and Co. the contract for the engines and dynamos at the electric lighting station, and to Mr. Sinclair the contract for the boilers, at the same price as formerly for similar plant. Councillor Johnston, in moving the adoption of the Gas and Electric Lighting Committee's report, said it was satisfactory to find that, notwithstanding the reduction of the price from 7d. to 6d., there was a favourable balance of £435. The committee recommended that the price should be still further reduced from 6d. to 5d., and they trusted that the reduction would have the effect of increasing the demand for the use of electricity in the city. The committee had likewise thought it advisable to reduce by one-half the charge for meters, which was rather heavy on consumers. Electric lighting had been so successful that the committee had had under consideration the question of still further extending the works at the station, and

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as regards this they would bring up a report as soon as possible. The report was adopted.

Bolton.—The following proceedings of the Gas and Streets Joint Committee have been approved by the Streets Committee: The sub-committee considered the question of adopting a system of electric traction for the Corporation tramways, and it was resolved that the borough surveyor and the electrical engineer be requested to prepare and present a report upon (1) the probable cost of the installation of the overhead electric driving power of the tramways; (2) the comparative working cost as between horse traction and electric traction; (3) the financial position of the Corporation with regard to the sinking fund on the first cost of the permanent way of the tramways and the additional cost of the overhead electric traction system; (4) the amount of the annual payment for sinking fund and interest combined, and the rent the Corporation would have to receive to make the new system a financial success; (5) the advantages the Corporation and the public might reasonably expect by the adoption of the electric traction; and (6) their general opinion upon any other points thought desirable to be brought before the Corporation on the subject, and that they be authorised to take such steps as they may deem necessary for obtaining the information requisite for the purposes of their report.

Anglo-American Telegraph Company.—The report of the directors of this Company, to be submitted to the meeting to day, states that the total receipts from July 1 to December 31 1895 including the balance of £831 brought forward from the last account, amounted to £165,589. The traffic receipts show an increase of £15 764, as compared with the corresponding period of last year. The total expenses of the half year, including the repair of cables, etc, as shown by the revenue account, amounted to £54,795, being a decrease of £1,056. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £98 794 Interim quarterly dividends of 10s. per cent. on the ordinary stock, and £1 per cent. on the preferred stock, were paid on November 1 absorbing £35.000, leaving £63,794, out of which the directors recommend final dividends of 18s. per cent on the ordinary stock, and £1. 16s. per cent. on the preferred stock, amounting to £63,000, making a total distribution for the year ended December 31 of £2 9s. per cent. on the ordinary stock and £4. 18s. per cent. on the preferred stock, leaving £794 to be carried forward to the next account The Company's repairing ss. "Minia" has been employed during the past half year in the repair of the 1873 cable, broken off the coast of Ireland, and of three cables between Newfoundland, Cape Breton, and the United States. She has also been employed by the Direct United States Cable Company for the repair of cables belonging to that company. Proceedings in the French lawsuit are still pending.

Leeds.—The Lamp Committee of the Leeds Corporation have decided to erect about 60 new ordinary lamps in different parts of the city. These are to be chiefly placed at Headingley, East Hunslet, Holbeck, and in the east and north wards. The large lamp now being erected in the City-square is to be lighted by electricity. At the top of the post there is to be a large arc light, which will be switched off every evening at 11 o'clock. At the same time the smaller incandescent lamps which are to be fixed on the two arms of the post will be switched on. The committee think this an admirable way of exercising economy. Some people had been bold enough to suggest that the structure would look more pleasing with four arms, but the committee reply that four large incandescent lamps would require as much electricity as an arc light, and therefore they don't see where their desired economy would come in At the Leeds County Court an action has been heard in which William Strafford Milestone, oil and paint merchant, Dock street, Leeds, sought to recover £10 damages from the National Telephone Company for trespass. Mr. Middleton, barrister (instructed by Mr. W. H. Forster), appeared for the plaintiff, and Mr. Middlebrook for the defendants. The plaintiff's case was that on August 15 last the defendants' men invaded his premises in his absence and proceeded to fix a telephone wire. On the plaintiff arriving and remonstrating with them, the foreman admitted that he had made a mistake and should have gone next door. Plaintiff had some valuable young homing pigeons, which were frightened away. His Honour found that the pigeons, which were worth 10s, had been lost, and he gave a verdict for five guineas, and certified for counsel.

Peterborough.—The Electric Lighting Committee of the Town Council have considered very fully the electric lighting question. At their last meeting they decided that the Corporation should apply to the Local Government Board for sanction to borrow the sum of £20,000 for the purpose of carrying out the scheme of electric lighting in the scheduled area of the borough. An amendment had been moved to this resolution, but was lost. The purport of the amendment was that having regard to the suggested great increase beyond the original amount estimated, the Corporation should offer to dispose of their powers under the provisional order to a company. The committee's action came before Council at their last meeting for approval. Alderman Percival said he objected to the resolution on the ground that the undertaking had not met with sufficient commendation, that the estimates were not reliable, the scheme was likely to incur a much larger expense than had been estimated, and, further, that the proposal in itself was very unfair to the general body of ratepayers. They proposed to borrow £20,000 upon the faith of the estimates of two gentlemen whose original estimate for the work was £12,000, which increased to £14,000, and jumped up to £20 000, with the information that these were not to be considered close estimates, or even estimates that were likely to be acted upon, because other alterations would be made. Mr. J. Hunting said in Peterborough they had had quite enough experience of the effects of monopolies, and they did not want the town to suffer by allowing a company to take over electric lighting. The estimates had been prepared by their engineer, and in all other cases they had been able to confide in his work. The minute of the committee was adopted by 11 votes to 6.

Preston.—There was a lively discussion at the Council meeting on the Streets and Buildings Committee's report, which contained the following recommendations: That the schedules of bills from this committee amounting to £2,152. 15s. 7d., £1,955. 10s. 9d., and £72. 19s. 4d., be passed for payment. That 30 electric arc lamps be placed in Lancaster-road, Corporation-street, Cheapside, Friargate, Lune-street, Fleet-street, Birley-street, Market-street, Orchard-street, Fishergate-hill, and Fishergate, as shown on the plan now submitted, and that the same be lighted by the National Electric Supply Company, Limited, together with the arc lamps at present in Fishergate, making a full total of 42, on the terms set forth in the company's letters on January 14 and 17, 1896—viz, to light the arc lamps of 500 c.p. each for 3,535 hours per annum for the sum of £14. 10s. each per annum, the company to find the lamps and carbons, clean and trim the same, and turn the lamps on and off Councillor Pearson, in moving the adoption of the report, said that, assuming all things to be equal, and that gas lamps were to be lighted 3,335 hours, the cost then would be £565. 18s 9d., or the difference between electricity and gas would be £43. 7s. 5d. But when they came to examine the candle-power they saw an immense difference. The 42 arc lamps, each of 500 c.p., would give a total candle-power of 21,000. The gas lamps, assuming that each gave 36 c.p., would only give a total of 3,406, so that they should have something like 17,540 additional candle power by electricity, and at a cost of £43. 7s. 3d. This practically meant that they got six times the quantity of light from the electric arc lamps. Eventually the report was adopted by 18 votes to 11.

Town and Village Company.—Under the title of the Town and Village Electric Light and Power Company, Limited (Parfitt's Patents) a company has been formed, with a capital of £100,000, divided into 19,800 ordinary shares of £5 each and 1,000 founders' shares of £1 each, for the purpose of acquiring letters patent granted to Messrs G. J. and G. J. T. J. Parfitt for the United Kingdom, for "an improved method of electric lighting in series, and apparatus therefor," together with the freehold land, plant erected thereon, stock-in-trade, and existing contracts of a syndicate now working the system; letters patent in respect of the same invention for the United States of America, the Empire of Germany, and the Dominion of Canada; and letters patent granted to Mr. G. J. T. J. Parfitt for the United Kingdom for "indicating light failures in electric lighting circuits, and apparatus therefor." The purchase price has been fixed by the vendor at £31,000, payable as to £8,200 in cash, £20,000 in fully-paid ordinary shares, £1,000 in fully-paid founders' shares and the balance of £1,800 in cash or ordinary shares, at the option of the Company. Of the ordinary shares 15,440 are offered to the public at par. In reference to this, the *Financial News* says: "If the Company succeeds in raising the capital it requires, we shall probably see before long a very considerable extension of electric lighting in provincial towns and villages. The Company proposes to acquire and work the Parfitt patents, which have been tried with success at Keynsham and Kingswood, and which, according to Prof. Silvanus P. Thompson, are both economical and effective. The Board of Trade return shows that the lighting of Kingswood is the cheapest in the United Kingdom, the rate made being only 2½d. per unit, and the cost being cheaper than gas."

Blackburn.—The town clerk (Mr. R. E. Fox) has issued his report upon the legal position of the Corporation, and as to the general effect of the tramway company's proposal: that the Corporation should, upon terms to be arranged, put down at their own expense the necessary plant for supplying the tramway company with electricity, and should also, at their own expense carry out the necessary works in bonding the tramway rails and erecting posts and other apparatus, and also provide electrical tramcars. The town clerk says that subject to the consent of the Local Government Board the Corporation have to borrow the capital necessary to enable them to put down the requisite machinery for providing the trams with electricity, but, seeing this does not apply to the purchase of tramcars, he does not think the Council should entertain that proposal. He has had an interview with the chairman of the tramway company, who "does not think there will be any insuperable difficulty on the part of the company in raising the necessary funds for this purpose themselves." The capital required by the Corporation is put at £13,000, and, taking the term of repayment as 15 years, the annual interest and sinking fund would be £1,089. In the opinion of Mr. Lacey the cost to the Corporation of production of electricity, including capital expenditure, should not exceed 2 5d. per unit, and that the total cost of working to the company would be 6d. per annum per mile, reducible by an increase of traffic. Assuming that the company were supplied by the Corporation with electricity at cost price, the annual cost to the company would be £4,725, while the average annual cost to them during the last three years has been about £6,187 showing a net annual saving to the company on electricity of £1,462 per annum.

Belfast.—The following report has been discussed by the Corporation: "The Belfast Street Tramway Company are promoting a Bill in Parliament authorising the use on their tramways of

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mechanical power, including electrical power, either carried in the carriages or generated in or applied from stations, steam power, locomotive, or stationary, and haulage by means of wire ropes, cables, or chains, or other appliances for the purpose of moving carriages and trucks, also for the laying down, construction, and erection of all machinery, plant, and works requisite for this purpose. Your committee are of opinion that such powers would seriously affect the interests of the ratepayers, and having had the report of the town clerk on the Bill (copy of which is appended hereto) before them, they have instructed him to have a petition presented against the Bill. Your committee consider it very desirable that the best information procurable on the subject of the electric traction in connection with street tramways should be obtained for the guidance of the Council, and they have, therefore, appointed the Lord Mayor, Alderman M'Connell (chairman of the Improvement Committee), and Councillor Andrews (chairman of the Electric Committee), with the town clerk and surveyor, to visit some of the chief cities and towns on the Continent where electric traction is used on street tramways, and to ascertain full particulars thereof, and to report to the Council thereon. The tramway company have also given notice of an application to the Privy Council for an order authorising the doubling of all their lines. The matter will require the careful consideration of the Council when the application comes before them, and should before that receive attention from the Law and Improvement Committees. Your committee have had interviews with several deputations from the districts proposed to be added to the city under the Bill promoted by the Council; but as definite arrangements have not yet been come to, they are not in a position to report the result, but hope soon to do so." The report was adopted, with the addition of the names of Alderman Lawther and Mr. M'Cowen (the electrical engineer of the city) to the deputation.

Liverpool.—At a meeting of the Waterloo District Council Councillor Killey moved, "That an agreement be entered into with the electric light company now promoting a Bill to enable them to supply the district with the electric light, embodying the terms agreed upon between the Parliamentary Committee of the Council and the company." Councillor Killey said they had secured very favourable terms, much better than those originally proposed by the company. The maximum price to be charged to ordinary consumers had been reduced from 1s. to 9d. per unit, the number of streets proposed to be lighted had been increased, a revision of prices would be made every three years, no site for a generating station could be utilised without the approval of the Council, and the charge for electricity for public purposes was fixed at two-thirds of the price charged to ordinary consumers. The resolution was passed. Mr. Charles Rettie has written to the *Journal of Commerce*, saying that at the last meeting of the tramways company the chairman made a remark that they had received an estimate to run the cars in Liverpool on the storage system, but as they wanted 7d. per car mile it was out of the question to adopt electricity on these tramways, as the cost of the horse-cars was only 5d. Mr. Rettie states that, though the above is quite correct, it is not generally known that the contractors were only asked to run 12 cars. If they had been asked to run the whole of the cars, which at that time were 245 in number, they could have run them far cheaper than by horses. The heavy gradients, he says, certainly make the working experiences of the tramway system greater than at Manchester and Glasgow, which places are very flat, but that is all the more reason why electricity should be used in a place like Liverpool for the tramways in preference to any other system. At a meeting of the Waterloo Parish Council, the deputy clerk said a letter had been receive from the County Council concerning the Ashton, Hyde, and District Electric Tramway, stating that they had been in communication with the Cheshire County Council with reference to the order sought to be obtained by the company, especially in regard to article 17, which related to the company having power to lay such posts and overhead electric wires in the streets as might be necessary for the working of the tramway. The construction of the tramway would affect many county bridges and roads, and the County Council, before taking steps to oppose the order, would be glad to have the opinion of the Waterloo Council upon it. It was decided to reply that, as the tramways would be of so much use to the inhabitants, they saw no reason for modifying the scheme.

Maidstone.—The Town Council have decided to dispose of their provisional order to a company. On March 14, 1894, the following resolution was adopted: "That this authority take the requisite proceedings to carry out the Maidstone Electric Lighting Order, 1892, by transferring the same to a private company on terms to be arranged by this authority, and sanctioned by the Board of Trade." At the last meeting Mr. Walter Cox moved the rescission of this resolution, and said it would be desirable they should keep the order in their own hands. He maintained that this was desirable, not only in the interest of the present ratepayers, but in the interest of those who would follow them. It was not right to yield up to a public company the order, as they would thus be creating a monopoly, and it would be a monopoly giving up all control of the order to a public company. He pointed to the Dover company and Rochester, the former of which, notwithstanding what he had mentioned about bartering with the shares, etc., were able to pay 20 per cent. dividend. He maintained that the scheme could be made to pay, for electricity was now out of its experimental stage. He was not asking them to carry out the order themselves at present, but simply to hold their hands so that they would be free to act at any time. It was decided by almost a unanimous vote to obtain the order, and he hoped by a unanimous vote that day they would decide to keep it. Mr. Corke seconded the resolution. Mr. Baker spoke against it, and said he was talking to an electrician the previous day, and he told him that electricity had not fully developed yet, and if they decided to carry out the order now they would have to do everything fresh at some future time. Considerable discussion took place on the resolution, which was, however, lost by 12 votes to 10. The consideration of the Electric Lighting Committee's report was deferred till next meeting. A company is being promoted by Mr. King who proposes to use the electricity not only for lighting, but for driving purposes. For the district he proposes to light, the works will cost about £25,000 or £30,000, the area of supply extending from Sittingbourne road to Barming and Tovil. The order embraces the whole of Maidstone, but the compulsory area comprises only High-street, Bank street, Week-street (as far as St. Faith-street), St. Faith-street, and along the Fair Meadow. The figure he proposes is about 6d. per unit at the commencement. The current will be conducted along underground wires and worked on the three wire system, probably under the new Board of Trade Act, which permits a house supply at the rate of 200 volts.

Bedford.—The Electric Lighting Committee have reported to the Town Council: "(*a*) That the work of public lighting is proceeding satisfactorily, and they hope that by the date arranged the standards will have been erected and the lamps lighted. The committee propose to have the gas standards, in the area in which electric standards have been placed, removed, and they recommend that it be left in their hands to make all arrangements for this purpose and to carry them into effect. (*b*) That a letter has been received from Messrs Sharman and Trethewy calling attention to the manner in which the electric cables were being laid, and that in River street the gas-mains were exposed, and saying that the gas company would not consider themselves responsible for any danger or damage that might be caused. The committee recommend that the gas company be requested (1) to permit the authority to take a tracing of their maps showing the position of the existing gas-mains, service pipes, and other underground works; (2) to give to the authority not less than three days' notice in pursuance of the Bedford Electric Lighting Order, 1890, before commencing to dig or make any trench for laying down or constructing any new mains or pipes or other works near to which any lines or works of the authority have been placed so as to protect from injury every main, pipe electric line, or work, and for securing access thereto. The electrical engineer has been considerably hampered with the street work owing to his not having a copy of the said map to refer to and also to the fact that he has in many instances discovered considerable underground leakage from the gas-pipes, etc., necessitating the immediate attention of the gas company. (*c*) That they have considered the question of extending the electric mains during the present year, and recommend that the authority borrow a further instalment of £12 000 on account of the loan of £27,000 already sanctioned for carrying out the following scheme: Public lighting only—St. Mary's, St. John's, all streets east side of Hitchin Railway, £1,000 Private lighting only—Bromham-road, Union-street, Ashburnham road (northern half) Goldington-road (to Bower-street), Rothesay road and gardens, De Parys-avenue (northern part). Park-avenue, Embankment (Newnham road to Bushmead-avenue) Kimbolton-road (to St. Augustine's-road), £8,750; machinery at central station, £2,500; contingencies, £250. Total estimated cost £12 500." Some debate followed on the consideration of this report, and with regard to Clause (*c*), Alderman Richards explained that it was necessary to prepare for private lighting before the street lighting. The public lighting could be easily carried out afterwards. Mr. Miller pointed out that the proposed expenditure would bring up the total to £40,000, and few of the ratepayers knew this. Although he acknowledged Mr. Johnston as a capable, practical man, yet he thought it would give more confidence to the ratepayers if the authority consulted an experienced electrical engineer as to whether they were proceeding on the right lines. He suggested that the matter should be held over until the committee presented a statement to show whether the electric light was being worked profitably. On the other hand, Mr. Taylor thought the light should be extended all over the town. The Clerk said the authority were bound to publish a full statement of the accounts relative to the electric lighting once a year, and they would have to be published before March 25. Alderman Richards said there would still be £4,500 left out of the loan sanctioned by the Local Government Board. It had been impossible to prepare a balance-sheet at present, but it would be submitted at the earliest opportunity. The report was adopted.

PROVISIONAL PATENTS, 1896.

JANUARY 27.

1848. Improvements in electric velocipedes and other vehicles electrically driven. Charles Adams-Randall, 1, The Avenue, Bedford Park, London.

1860. Improvements in the method of and means for protecting electric lamp fittings from corrosion and for preventing "short-circuiting." Joseph Lomax Kendal, 5, John Dalton street Manchester.

1867. Improvements in apparatus for straining electrical conductors in culverts. Sydney William Baynes, 33, Haverstock hill, London.

1888. Improvements in dynamo-electric machines. Sebastian Ziani de Ferranti, 27, Charterhouse-square, London.

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1905. Improvements in furnace-blasts, and in process and in means or apparatus for electro-thermally treating materials, for the reduction of metals, production of carbides, acetylene, cyanogen, cyanides, nitrides, and the fixation of nitrogen. Hudson Maxim, 45, Southampton-buildings, Chancery lane, London.

1927. Improvements in electric railway systems. Moses Lindley Wood, 31, Southampton buildings, Chancery-lane, London.

JANUARY 28.

1958. Improvements in and relating to electric gas-lighters and extinguishers and the like. James Tarbotton Armstrong and Carl Gustaf Georg Braunerhjelm, 64, Aldersgate-street, London. (Complete specification.)

1963. A new or improved electrical switch. Samuel Glover, 70, Market-street, Manchester.

1979. Improvements in conduits for conductors of electricity. William Henry Lane, 52, Halliford-street, Essex-road, Islington, London.

1992. Improvements in electric arc lamps. Ernest John Bagnall and George Arnold, 18 Buckingham-street, Strand, London. (Complete specification.)

2003. Improvements in telegraph repeaters. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Benjamin Frederick Merritt, United States.) (Complete specification.)

2029. An improvement in electric glow lamps. Richard Bruno Roxby, 53, Chancery-lane, London.

2043. Improvements in multiple telegraphy. Thomas Bullitt Dixon, 18, Southampton buildings, Chancery-lane, London (Date applied for under Patents etc. Act, 1883 Sec 103, September 12 1895, being date of application in United States.) (Complete specification.)

JANUARY 29

2051. Improvements in electrical resistance thermometers. Henry Robert John Burstall and Henry Frederick William Burstall, 76 King's-road, Camden-road London

2053. Improvements in so-called unipolar dynamos for generating continuous electric currents, applicable also to continuous-current motors and continuous-current transformers. Leopold William Heath, 21, Brunswick street, Chorlton on Medlock, Manchester.

2056. Improvements in and connected with magneto-electric machines for electrically lighting cycles and other vehicles. Robert Bryan Hayme-, Henry Edward Charles Walcott, John Bruce Collier, and Edwin George Bryant, Upper Terrace road, Bournemouth

2074. Improvements in the construction of lamp and bracket reflecters for electric, gas, and other lights. John Parker, Sunbridge chambers Bradford.

2106. Improvements in lightning dischargers for electrical installations. Siemens Bros and Co., Limited, 28 Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

2107. Improvements in telephones. John Imray, 28, South ampton-buildings, Chancery-lane, London. (La Société Anonyme pour la transmission de la force par l'Electricité, France.)

JANUARY 30.

2161. Improvements in apparatus for conveying electric current from overhead conductors to motors on tramways or like vehicles. Philip Dawson, 47, Lincoln's-inn-fields, London.

2176. Preserving meat by the help of electricity. Adel Barreto Pinto, 97, Newgate-street, London. (Complete specification.)

2194. Improved means, applicable for use in electric arc lighting, for regulating the distance between the carbon points. Otto Bondy and Albert Jordan, 191, Fleet-street, London.

2197. An improvement in the preparation of electrolysed chloride solutions for disinfecting and like purposes. Eugene Hermite, Edward James Paterson, and Charles Friend Cooper 28 Southampton-buildings, Chancery-lane, London.

2199. Improvements in apparatus for transforming alternating into continuous electrical currents, or conversely. John Imray, 28, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la transmission de la force par l'Electricité, France.)

2224. Improvements in prepayment mechanism for electrical or other meters. Charles Orme Bastian and Herbert Cecil Hodges, 31, Southampton buildings, Chancery-lane, London.

JANUARY 31.

2248. Improvements in electrical cut-outs. Hugo Hirst, 88, Queen Victoria-street, London.

2254. New or improved electrical appliance for extracting broken drills from boreholes. Frederick Walker and Walter Callis Sanderson, The Arcade, Barnsley.

2285. An improved method of manufacturing refined bitumen for asphalte, electrical, and other purposes. Charles William Bradshaw and Herbert Antonio Henry Moore, 40, Chancery-lane, London.

2249. Improvements in and connected with fuses for electrical cut-outs. Hugo Hirst, 88, Queen Victoria street, London.

FEBRUARY 1.

2324. An improved electric coupling. John Henry Tucker, 16, Oozells-street, Birmingham.

2328. Improvements in hanging lamps for gas, oil, or electric light. Joseph Benjamin Bruce, Ernest-street, Holloway Head Birmingham.

2335. Improvements applicable to electric meters. William McWhirter, 87, St. Vincent-street, Glasgow.

2337. Improved means for use in working apparatus by electricity. Gaston Emmanuel Sautter and Henri Harlé, 47, Lincoln's-inn fields, London.

2348. Improvements in electric switches. Jan Meines Huisman and Henry Charles Gover, 62, St. Vincent street, Glasgow.

2382. Improvements in dynamometers. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (George Washington Lewin, United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED

1892.

11424. Telephone, etc. Dymond. (Strowger.) (Second edition.)

1895.

437. Arc lamps. Barton. (Jandus.)

527. Galvanometer lamp, stand, and scale. Burstall and Hicks

1536. Electric motors. Brown and others.

2303. Electric lamps. Hermand.

2804. Effecting electro-chemical decompositions. Imray. (Diehl.)

5003. Electric condensers. De Ferranti.

5086. Electric lamps. Cowx.

5936. Electrically-propelled vehicles. Siemens Bros. and Co., Limited (Siemens and Halske.)

18036. Battery electrodes. Leitner and Reicher.

19374. Incandescent electric lamps. Cox.

19838. Arc lamps. Adams

23354. Electric heating devices. Le Roy.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1-1½
—— Non. Cum., 6 per cent. Pref.	2	1⅞ 1¾
—— 4½ per cent. Debenture Stock	100	112-116
Charing Cross and Strand	5	5¼-5⅝
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7¼
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	16-16½
—— 5 per cent. Debenture Stock	100	134 138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	118-122
—— 5 per cent. Pref. Shares	10	4½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10½-11
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1½-1¾
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅞ 1
—— 7 per cent. Cumulative Pref.	2	2-2½
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	¾ 1
Fowler-Waring Cables	5	1-1¼
W. T. Henley's Telegraph Works, Ordinary	10	13½-14½
—— 7 per cent. Preference	10	15½-16½
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	3¾ 4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	103 105
Kensington and Knightsbridge Ordinary	5	7⅜-8½
—— 6 per cent. Pref.	5	6¾-7¼
Liverpool Electric Supply, Ordinary	5	7⅛-8⅛
Liverpool Overhead Railway	10	12⅝-12½
—— 5 per cent. Pref.	10	16-16½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅞-1
Metropolitan Electric Supply	10	11½-12½
—— 4½ per cent. First Mortgage Debenture Stock	100	115-118
National Telephone, Ordinary	5	6⅜-6⅞
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16-17
—— 5 per cent. Non. Cum. Third Pref.	5	6½-6⅞
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	8½-9
Oriental, Limited, £1 shares	1	1⅛-1⅜
—— £5 Shares	5	8-8½
—— £4½ shares	4½	6½-6⅞
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-106
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	9-10
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	44-46
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	5-5½
Westminster Electric Supply, Ordinary	5	9-9½
Yorkshire House-to-House	5	6¾-7¼

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NOTES.

Indian Lighting Rules.—The Electric Lighting Bill passed by the Bengal Legislative Council has received the assent of the Governor-General in Council, and the new Act as well as the draft rules have been published in the *Calcutta Gazette*.

Electricity v. Steam.—According to the New York *Electrical Engineer*, the Cleveland, Akron, and Columbus Railroad Company has taken off its road four passenger trains on account of the electric line competition between Cleveland and Akron.

Anniversary.—Lord Kelvin will shortly attain the fiftieth anniversary of his induction to the Chair of Natural Philosophy in Glasgow University, and steps are being taken to celebrate the jubilee in such fashion as will mark the high appreciation in which the venerable physicist is held.

Amazon Telegraph Cable.—The cable communication between Para and Manaos, the capital of the province of Amazonas, has been successfully completed, and messages of congratulation have been exchanged between the directorate of the Amazon Telegraph Company in London and the Brazilian Government.

Finsbury Technical College.—The students of the City and Guilds Technical College, Leonard-street, Finsbury, will hold their biennial conversazione on Thursday, February 20, when Prof. Silvanus P. Thompson, D.Sc., F.R.S., will lecture on "Invisible Light and its Photography." The programme also includes a concert and dance, while the whole of the college not used in the entertainment is to be given up to exhibits of model machinery, electrical appliances, and chemical manufactures.

Safety Device.—The *Electric Railway Gazette* contains a description of a device designed to prevent accidents which has been invented by Mr. A. K. Bonta, chief engineer of the North Hudson County Railway Company, of Hoboken, New Jersey. The principle is the arrangement about the steam-engines of a system of air-pipes provided with glass air-tubes, which, when broken, allow the compressed air to escape. The reduction of pressure then brings into action a valve, and shuts off steam from the engines. The pressure is maintained in the air-tubes by a pump of the Westinghouse air-brake type.

Telephoning a Wreck.—When the American liner "St. Paul" went ashore at Long Branch, the New York and New Jersey Telephone Company promptly fitted a telephone line from the shore to the stranded ship. The New York *Electrical Review* describes the line, which was part of an emergency stock kept by the company, and states that conversation was successfully maintained and business was brisk over the line. The "St. Paul" was entered in the company's directory as "No. 125 Long Branch." The above may be taken as a fair example of what private enterprise will do.

American Trolley Patents.—The United States Circuit Court of Appeals, on reviewing Judge Coxe's Elmira decision relating to the Van Depoele patent on overhead trolley devices, has given a judgment reversing some of the points sustained by Judge Coxe. The claims for a combination with an overhead conductor arranged to receive a travelling underneath contact of a switching device secured to and depending from the conductor, have been declared void, owing to lack of novelty. The claims embracing among their constituents an overhead wire and a grooved contact device or devices, and the claims relating to the trailing trolley and relative arrangement of trolley switches and branch switches, are sustained.

Electric Towage.—A full text of the report of the State authorities as to the electric towage experiments made recently on the Erie Canal is printed in the *Western Electrician*, and gives further details than have hitherto been available. It is stated that the tests were not made under the best conditions, the E.M.F. varying considerably, and the power developed by the motor averaging only about one-third of its capacity. Nevertheless the results go a long way towards demonstrating that electric towage is practicable and full of promise in point of economy. With the vessel used the average speed was 2·5 miles per hour, requiring 8·5 e.h.p. for the 117·5 tons towed, and the price is worked out to be far short of the present cost of towage.

Society of Chemical Industry.—At a meeting of the Nottingham section of this society, Mr. L. Archbutt, F.I.C., made a communication on the ignition of sawdust by nitric acid, in which the author gave an account of experiments made to find out what danger attaches to the usual way of packing bottles containing this acid in sawdust when delivered for transit to the railway company. On a complete breakage, in one case, ignition occurred readily, the mass of sawdust bursting into flames, and in all cases, even with comparatively weak acids, danger was apparent. Mr. Archbutt said that he would recommend the use of kieselguhr, or some similar absorbent material, for the safe packing of bottles containing dangerous acids. No doubt this would be the best way if everyone stored kieselguhr, but they do not. On an emergency, why not try sand?

Construction Rules in the States.—The meeting of the representatives of various American electrical associations who have been invited by the National Electric Light Association to consider the adoption of a standard set of rules for electrical construction and operation is to take place on March 18. The bodies asked to send delegates are the American Institute of Electrical Engineers, the American Street Railway Association, the National Board of Fire Underwriters, the International Fire Chiefs' Association, the American Institute of Architects, the American Bell Telephone Company, the Western Union Telegraph Company, the Postal Telegraph Company, the General Electric Company, and the Westinghouse Company. The delegates are to form a committee with a view to securing the promulgation and enforcement of one standard set of rules for electrical construction and operation.

Niobium Filament Lamp.—Inventors show no inclination to rest satisfied with carbon as the material for incandescent lamp filaments, and the New York *Electrical Engineer* describes a new lamp due to Mr. J. W. Aylsworth, of Newark, New Jersey. In this case the incandescent conductor is made from such refractory metals as niobium, tantalum, molybdenum, titanium, or zirconium, and the method by which the filament is prepared consists in heating a base or support in the vapour of a volatile halogen compound of the element which it is desired to deposit, simultaneously mixing with the vapour a reducing gas, such as hydrogen. Mr. Aylsworth has succeeded in depositing in this manner tantalum, niobium, molybdenum, titanium, and zirconium, continuing the process in each instance until the carbon core or other conducting filament is surrounded by the metal. It is stated that a niobium lamp prepared in this manner has been run on test for some months past and shows very high efficiency and long life.

East of Scotland Engineers.—At the meeting of the East of Scotland Engineering Association at Edinburgh,

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Prof. Armstrong in the chair, Mr. A. R. Bennett read a paper, in which he remarked that several important facts connected with the telephone question had recently been presented in a manner which advocates of the existing state of matters in the United Kingdom had not seen their way to challenge. These facts included the smaller rate of subscription paid in foreign countries to that in the United Kingdom; that the greatest degrees of development were attained by means of local enterprise; that the telephone was put to more numerous uses abroad than in this country; and that competition between two telephone companies within the same area had a stimulating effect on the growth of telephone work. He argued that the policy of the Post Office did not tend to improve matters, and then showed how easily private companies might be formed.—Mr. D. M. Stevenson has also been enforcing somewhat similar views before the Glasgow Chamber of Commerce.

Electric Fish.—M. d'Arsonval has communicated to the Société française de Physique the results of his experiments with the electric ray. The curve of the discharge is very similar to that of the contraction of a muscle—namely, a rapid increase of the ordinates followed by a slower decrease. But the curve contains indentations showing that really there are several discharges—the usual number is eight—with a total duration of ·1 to ·15 of a second. With an open circuit a difference of potential exceeding 300 volts can be measured between the dorsal and ventral surfaces of the electric organ, but measurements of the discharge indicate a much lower effective voltage. The discharge can only be repeated a few times in succession, after which a period of rest is necessary. The analogy between the cells of the electric organ and the elements of a voltaic pile is apparent only. No electric effect is obtainable without a muscular contraction, and M. d'Arsonval considers the cause must be sought in a variation of the contact surfaces in the cells of which the organ is composed, and he refers to some experiments of M. Lippmann on this point.

Endowment of Research.—In connection with recent electrical researches at the Bengal Presidency College Laboratory, the Provincial Government has made a grant of Rs.1,000 to defray the cost of a more elaborate form of apparatus devised by Prof. J. C. Bose for his experiments. The Government has also established a permanent "science research fund" for the continuation of these researches. An astronomical observatory will shortly be constructed, where the splendid telescope by Grubb, recently presented to the physical laboratory by his Highness the Maharaja of Tippera, will be installed. An important work undertaken by Mr. Bose is the continuous record of the variation of three elements of terrestrial magnetism. The construction of a complete magnetic observatory equipped with the latest pattern of Kew instruments has been sanctioned by the Government, and will be soon taken in hand by the Public Works Department. The frequency and intensity of magnetic storms, and their connection with terrestrial and solar disturbances, will be among the problems that will be specially studied. The absolute value of the horizontal magnetic force of Calcutta is being determined from a series of observations extending over the past three years.

The Patent Office.—Mr. Kenric Murray, secretary of the London Chamber of Commerce, has written to Sir Henry Reader Lack, the Comptroller-General of the Patent and Trades Mark Office, calling attention to the fact that the librarian of the Patent Office of the United States of America is making a collection of illustrated and other trade catalogues, price-lists, circulars, and similar publications for reference by those instituting enquiries in regard to patents, designs, and trade marks, or making use of the Patent Office library, and suggesting that such a collection of records at the English Patent Office would be exceedingly valuable, as by this means there would be permanently preserved an enormous amount of extremely useful material which might on occasion elucidate the meaning of many trade terms and usages. Sir H. R. Lack has replied as follows: "I beg to acknowledge the receipt of your letter of the 27th inst., suggesting, on behalf of the London Chamber of Commerce, that a collection of illustrated and other trade catalogues, price-lists, and similar publications should be made and filed in the Patent Office library, and, in reply, to inform you that the nucleus of such a collection was formed some 20 years ago, and has since that date been gradually extended. In view, however, of the suggestion of the London Chamber of Commerce, I shall be happy to consider how far it may be possible to render this collection more complete and to make it more easily accessible for public reference."

France.—From the statistics of electric lighting and power stations in France compiled and published by *L'Industrie Electrique*, it appears that at the end of 1894 the number of these stations, excluding those in Paris, was 328; by the close of 1895 it had risen to 438. Of these, 378 furnished returns as to horse-power; the highest figures being for steam, 26,802 h.p. at 126 stations. Producer gas is used at six stations, furnishing 208 h.p.; and ordinary gas at 13 stations, giving 1,605. There is one 12-h.p. petroleum plant. The number of water-power stations exceeds that of steam, being 182, but the aggregate horse-power is only 11,665 h.p. There are 48 mixed plants. Alternating currents do not at first sight make a very good show, since these are used only at 75 stations, and to an aggregate of 14,927 h.p., as against 295 stations and 31,955 h.p. for continuous currents. Four stations use polyphase currents to an aggregate of 850 h.p. It must, however, be noted that many of the stations returned are very small ones; and consequently a comparison with, say, the electric supply companies and corporations in England would be quite fallacious. With the addition of the Paris stations and those from which returns could not be obtained, it is estimated that the whole of the French generating stations would show an aggregate of 65,000 h.p. With reference to stations in progress or projected, our contemporary gives up the attempt to tabulate them, with the remark that "they are too numerous."

Choosing a Motor.—Dr. G. H. Zahn, writing on this subject in the *Western Electrician*, discusses the various points which should be considered in the selection of a machine. It should be noted at what load a motor commences to spark, at what load the temperature rises abnormally, what the efficiency is at different loads, and at what speed it runs. It is most important to consider whether the motor is to be run generally at full load or at less than its full load; in the former case the efficiency curve should have its maximum at full load, and in the latter at about the usual load at which it is to be run. In reference to the use of generators as motors, Dr. Zahn remarks that "it is generally known that a good generator will give good results if used as a motor. This holds good if the machine be running under suitable conditions, as considered above—*i.e.*, if it be chosen with a view to the kind of work to be performed and its efficiency at different portions of the load. But if a lighting dynamo is used as a motor its available brake horse-power will be some 30 per cent. less than the belt horse-power to run it as a generator, and the speed will be about 10 per cent. less than that given for the dynamo. The nature and conditions of the work the motors have to do are so various that they cannot

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be standardised in the same way that the lighting dynamos can. There are three classes of lighting dynamos, according to the winding of the magnets—the series, shunt, and compound-wound machines. But there are many ways of winding the field magnets of motors, each adapted to a particular purpose." It is added that small multipolar machines have no advantage over bipolar ones.

Motorcarts.—The Self-Propelled Traffic Association desire to point out that they are in no way connected with the newly-formed Motorcar Club. The president of the association is Sir David Salomons, Bart., and among an influential council the names may be noted of Sir Frederick Bramwell, Bart., Sir Albert K. Rollit, M.P., Right Hon. G. Shaw-Lefevre, Prof. Boys, Messrs. A. Siemens, Rucker, and G. J. Jacobs (president of the Institute of British Carriage Manufacturers). The association sent an influential deputation to Mr. Chaplin on Wednesday upon the subject of amending the Locomotive Act, or of introducing a new Bill to facilitate locomotion on highways, when Sir David Salomons pointed out to the right hon. gentleman that horseless carriages had recently been introduced on the Continent with great advantage to agriculture, and explained that it was only the state of the present law that hindered their adoption here. Mr. Thornton, of the London County Council, said the Highways Committee of that body were very anxious that these vehicles should be introduced into the Metropolis, as they would be a great boon in congested thoroughfares, seeing that they would take up much less space than carriages drawn by horses. Mr. Chaplin stated that he was fully in sympathy with everything said by the deputation. A Bill was now being prepared by the Local Government Board, and he hoped, with the assistance of Mr. Russell, to carry it without opposition through the House this session. In connection with this subject, it may be added that the *Imperial Institute Journal* states that arrangements have been made for holding an international exhibition of motor carriages at the institute from May to August next. The latest developments of motor carriages supplied by the agencies of oil, steam, electricity, or compressed air will be shown. The allotment of space and the control of the display will be undertaken by the Motorcar Club.

Electricity in Collieries.—At a meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers, Mr. I. Meachem, jun., supplemented his paper read at a former meeting on "The Electric Power Plant at Haden Hill Colliery." He said the installation had now been at work about six months, and it was possible to judge of its merits. The total cost of the installation was £2,289, while a steam plant would cost £1,089 less, but, on the other hand, they had the advantage of light and a saving of £73 per annum in candles, and a saving of £30 per annum in the lights on the bank. Altogether there was a saving of £102 per annum. The result of the change, according to their sheets, showed a net reduction of cost equal to 3½d. per ton, or on the output £40 a week. They had therefore every reason to be satisfied with the result of the experiment. Mr. Henry Lea, who opened the discussion, said he had inspected the Haden Hill installation. The working of the underground plant certainly was everything that could be desired. The simplicity of the arrangements and the ease of control were very striking. There was, of course, the absence of heat and leakage of steam and condensed water, which would have been met with if there had been a steam-engine in the mine doing the same work. The Chairman said he had yet to be convinced, although he had a 60-h.p. plant in work, that steam-engines fixed on the surface and ropes taken down the shafts could be beaten. In reply to the chairman, Mr. Meachem said that the cost of labour in connection with the installation was ·47d. per ton. Mr. Brown said there was no doubt electricity would not compete with rope haulage for short distances, but where long distances had to be dealt with electric haulage was a considerable advantage. It was quite possible to prevent the dangers arising from sparking, even though the machine might be sparking in the midst of explosive gases. Motors were now made so that they could work with them wherever they could work with a safety-lamp.

Technical Education.—We have received this year's (1896) programme of the Technical College, Exhibition-road, South Kensington, in connection with the City and Guilds of London Institute. It may be noted that the college continues to maintain its reputation, and that the number of students applying annually for admission largely exceeds the number than can be taken. It follows that the matriculation examination, which is held on September 21 this year, is not a matter of form, as is too often the case in kindred institutions; and only those students likely to profit by the course of education are allowed to pass, so that a high standard is maintained. The number of scholarships to be competed for on matriculation is increasing. These consist of one Clothworkers' scholarship of £60 per annum and free education; three Institute's scholarships, each covering the cost of education; one Siemens's Memorial scholarship of £50 per annum for three years—this is awarded every third year, the next award being in 1897; one Mitchell scholarship of £40 per annum with free education, to be awarded to holders of Mitchell scholarship at the Central Foundation School or at the Finsbury College. There are also five Clothworkers' scholarships, each tenable for five years for boys from a public scholarship, of which the last three years can be passed at the Central Institution. There are also a number of scholarships, premiums, medals, etc., which can be gained by students while at the college. The diploma of associateship is not granted indiscriminately to all the students who pass through the course. Thus we see that since 1887 only 187 diplomas have been granted, while some 154 students, who have either not completed their course or have not reached the requisite standard, have received first or second class certificates. This not only encourages ability and enforces diligence on the part of the students, but completely discountenances the idea that it is only necessary to secure attendance on a three years' course in order to make a competent engineer out of anybody.

Institution of Civil Engineers.—At last Tuesday's meeting Mr. A. E. Hunt, M.I.C.E., read a paper on the manufacture of aluminium by the Pittsburgh Reduction Company at Niagara Falls. Mr. Hunt said the Hall process, which was that adopted by the Pittsburgh Reduction Company, involved the direct electrolysis of the sesqui-oxide, alumina, dissolved in a molten bath of the mixed fluorides of aluminium, calcium, and sodium. One cubic foot of the solvent would serve for an hourly production of one pound of metallic aluminium, the bath used being capable of dissolving one-third of its own weight of alumina. The electrical energy required for extracting this amount of metal was 3,730 watt-hours for the decomposition of the alumina, with a further supply to maintain the bath at the temperature necessary for the molten condition. The fluorides remained unchanged, so that the operation was continuous. The bath was made either from a mixture of fluorspar and cryolite, or from the artificial fluorides; and it might be fused in a separate vessel when starting work, or in the bath by the current itself. Alumina was added at frequent intervals to prevent too great a variation in the resistance of the bath, and the aluminium,

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as it was produced, was syphoned from beneath the layer of fluoride, where it collected, without interference with the progress of the operations. The oxygen of the alumina was liberated at the carbon anode, which, at the temperature of the bath (980deg. C.) oxidised to carbon monoxide. Outside the bath this was burnt at once to carbon dioxide, and was allowed to escape into the working apartment. The carbon anodes were consumed at nearly the same rate as the aluminium was produced, the amount being about two-thirds of the quantity actually used. The difference of potential theoretically necessary for the separation of the constituents of alumina was about 2·8 volts, but a greater difference was due to the resistance of the bath. The pots employed were of iron with carbon linings, but these could be dispensed with if a high degree of purity was not required. The chief impurities in the finished product were silicon and iron. These were derived from the alumina as well as from the carbon anodes. Aluminium could be produced containing 99¾ per cent. of the pure metal, and was regularly delivered with 99 per cent. The electrolytic baths were joined in series, and all the copper connections were necessarily very heavy on account of the large currents employed.

Acetylene.—M. E. Hospitalier, of the Paris Ecole de Physique et de Chemie, has delivered a lecture on "Calcium Carbide and Acetylene" before the Société International des Electriciens, which is reproduced in full in *L'Industrie Electrique*, and summarised in other French papers. M. Hospitalier notices the difference between the figures of M. Moissan, who, using a current of 350 amperes at 70 volts, works out 40 kilowatt-hours per kilogramme of carbide produced, and those of Mr. Wilson, who, using an industrial plant, obtains the same amount with 1·6 kilowatt-hours, and remarks that the present price charged for the carbide by the Aluminium Industrie Aktien-Gesellschaft at Neuhausen is 400fr. per ton. Either direct or alternating currents can be used to produce the carbide—M. Hospitalier considers the latter preferable—and it is at present manufactured in quantity in America by the Electric Gas Company, in Germany by the Carbid at Berlin, in Switzerland by the Aluminium Aktien-Gesellschaft at Neuhausen, and in France at Froges and Vallorbes. In reference to the properties of the gas, the conclusion is confirmed that it is not in any respect poisonous as was at one time supposed. It is, of course, not respirable, but a mixture in as large a proportion as 40 per cent. appeared to have had no harmful effects on animals breathing it so long as care was taken that a sufficient quantity of oxygen was present. According to Berthelot, however, acetylene is an endothermic gas, and is liable to spontaneous decomposition by a detonator, a question which would have to be considered before it is laid in pipes all over a town like ordinary gas. Although acetylene attacks silver and copper with the formation of explosive compounds, it is without action on iron, lead, and tin, and at ordinary temperatures does not seem to attack sensibly either zinc, brass, or bronze. It follows, therefore, that ordinary gas piping and fittings can be used with acetylene. It is concluded that acetylene produced from calcium carbide will never prove a formidable competitor with gasworks or electric lighting. But the facility with which it can be produced and transported in a liquid state, under pressure, allows of the development of acetylene lighting in country houses, pleasure resorts, and factories situated at a distance from towns. The central electric lighting stations might make up their day load by the manufacture of either calcium carbide or liquefied acetylene for sale beyond the district served by their mains, the result being equivalent to the transport and distribution of electric energy to a distance. It is, however, desirable that the central stations should take up this business without losing time, because M. Hospitalier thinks that there is a considerable probability that calcium carbide may soon be obtained by an exclusively metallurgical process, and possibly as a by-product.

The New Photography.—Mr. Campbell Swinton, assisted by Mr. Stanton, gave a demonstration of photography by means of the Röntgen radiations before the Royal Photographical Society on Tuesday last. The conditions in Hanover-square not being convenient for the use of the Tesla coil apparatus formerly described, Mr. Swinton on this occasion used a Ruhmkorff coil giving a 1½in. spark, and took the usual pictures of metallic objects enclosed in cases, and the human hand, the results being developed on the premises and subsequently exhibited in a lantern. Much interest was displayed in the subject, and the room was inconveniently crowded. With his Tesla coil Mr. Swinton stated that he had succeeded in reducing the exposure for the living hand to 55 seconds, and he is pursuing investigations with a view to bringing the exposure necessary in this kind of work within more reasonable limits. With the Ruhmkorff coil, of course, longer exposures were necessary. One "wrinkle" may be noted, and that is, wherever possible, a series of short exposures should be given instead of a long continuous one, as the glass opposite the cathode becomes very hot under the action of the discharge, and there is great danger of destroying the tube. The succession of short discharges gives time for the tube to cool. At the conclusion of the demonstration there was some discussion, Mr. Gifford remarking that, so far as his experience went, it made no difference to the result whether "rapid" or "ordinary" photographic plates were used. An experiment also described by Mr. Gifford is also interesting from a theoretical point of view. On placing on the sensitised plate pieces of uranium and ordinary glass, Mr. Gifford found that the fluorescing uranium glass appeared more opaque to the new rays than the common glass. The obvious explanation is that a certain amount of the energy of the ray is absorbed to produce the fluorescence, but the experiment ought at once to put an end to the theory, which was started in Germany simultaneously with their discovery, that the action of the rays on the silver salt is indirect, and is due to an (invisible) fluorescence of the glass back. Captain Abney, the new president of the society, was present at the demonstration, but confined his observations to a protest against calling the new process "photography. From this it may be inferred that he does not consider the rays to be of the same character as light rays. On the same principle, objection might be taken to calling the new radiations the "X" rays until their longitudinal vibration is definitely established. Much interest continues to be taken in the subject, both in England and on the Continent. Prof. Wittmann, of the Technical High School, Budapest, is reported to have succeeded in reducing the time of exposure for obtaining well-defined photographs to three minutes in ordinary cases, and to 30 seconds under very favourable conditions. His method is permanently to connect the mercury pump with the vacuum tube. Most applications of the new discovery appear to be surgical, but at Berlin the new radiation photographs have been used to distinguish real from imitation pearls, while the Vienna War Office has ordered a series of experiments to be carried out in the Government gun factory at the Vienna Arsenal for testing the homogeneousness of castings for gun tubes by the use of the new rays. As metals are more opaque than any other substances to these radiations, great success in this direction is hardly to be hoped for.

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THE TELEPHONING OF RAILWAYS.

BY J. PIGG.

Considerable attention has at different times been given to the most suitable methods of arrangement for the telephone service of large towns, and spirited debates have frequently taken place respecting the arrangements most likely to produce an efficient service. The writer, however, is not aware that any suggestions have been put forward publicly for the most efficient arrangement of telephone circuits in their adaptation to the special requirements of the railway service.

Of the suitability of the telephone for a very large amount of railway work there can be no question whatever. As a means of communication, it is immeasurably superior to the single-needle telegraph instrument, the predominant type on railways, in that it is quicker, allows greater detail of arrangement, and enables the communicants to come directly together without the intervention of a third party. The use of the telephone for the great variety of detail arrangement required by railway work has advanced of late years more rapidly than that of any other instrument, and the total number in use for railway work must form a respectable proportion of the total number in use for all purposes. Whilst this is undoubtedly the case, it would be unsafe to predict that the use of the telephone in rail way management has reached its maximum. Rather, it would appear as if it was, to use a somewhat well-worn simile, as yet "in its infancy."

To anyone acquainted with the means taken to obtain telephonic communication, and the results accruing, a question naturally arises as to whether the arrangements made are the best that can be devised to obtain the maximum benefit from the circuits erected, and also whether these arrangements are such as to readily co-operate to the best advantage with the extension of the telephone that seems inevitable. Whilst it is true to a very great extent that those who are to work any given telephone circuit are best able to specify the points requiring to be connected, yet it is inevitable that individual arrangements are not likely to be conducive to general effectiveness. It is, perhaps, in consequence of this that the arrangement of railway telephone circuits has been allowed to settle itself to suit purely local requirements, and the maximum capacity of the circuits, as a means of general communication, has up to the present been ignored, to the manifest disadvantage of the general service.

The executive work of a railway is carried on in departments, each of which is under one head, who is assisted by divisional superintendents located at different points in the system, and who, again, are assisted by subordinate officials located at different points in the divisions. In this way almost every department is represented at each of the more important centres of traffic. The work of each department is to a great extent distinct, but, necessarily, the work of each must be carried out in conjunction with that of other departments, whilst much of the work is stereotyped and of a local character only, yet, without going into details, it will be readily seen that the necessity for quick communication between (*a*) officials of the same department in the same locality; (*b*) officials of different departments in the same locality; (*c*) officials of the same department in different localities; (*d*) officials of different departments in different localities, will frequently arise, and much valuable time may be lost for want of adequate means of communication. Hence, in railway work there seems to be four distinct classes of communication to be provided for. Those under the first two heads may, for reference, be termed "local," the third "departmental," and the fourth "inter-departmental," although it is evident that no strict division on these lines can be made, since, in the "local" division, "departmental" and "inter-departmental" working is found.

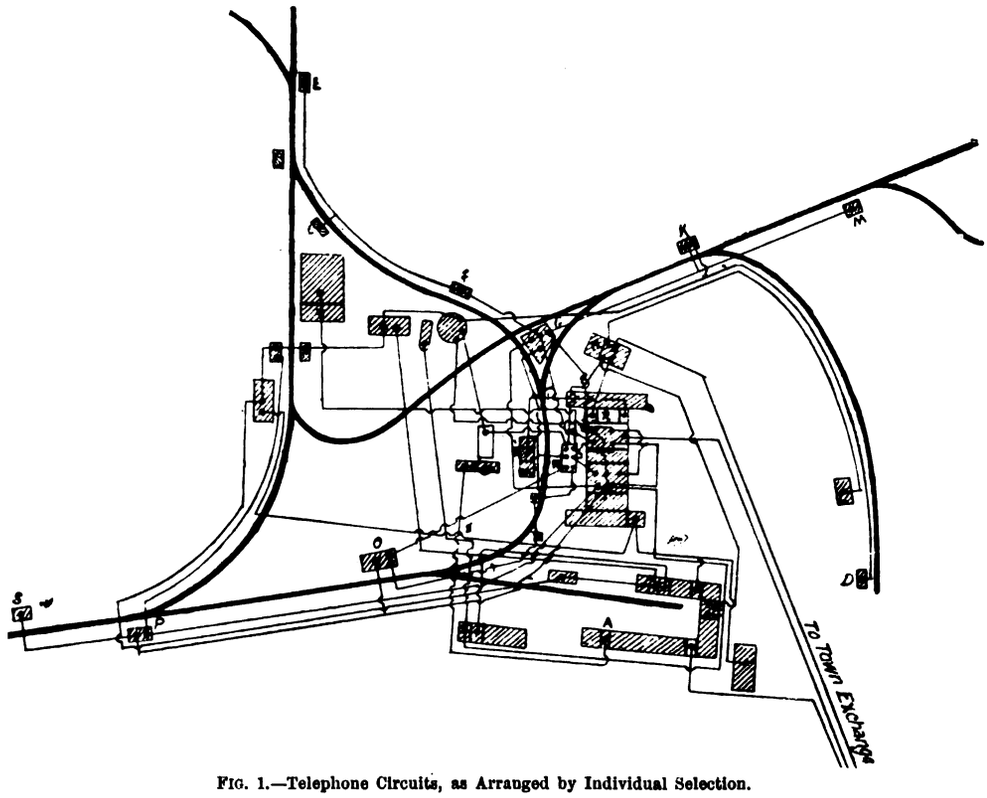

FIG. 1.—Telephone Circuits, as Arranged by Individual Selection.

Considerable progress has already been made in providing telephonic communication of a "local" character in the more important centres of traffic, and in connecting local collecting and distributing areas, but little progress has been made in the other divisions, chiefly owing, no doubt, to the fact that hitherto telephones have been installed on the initiative of some department which felt the need of such accommodation, and the calling points selected to suit the needs of that department alone. The usual course pursued is, when the head of a department recognises the necessity for quicker means of communication, for that department to secure the erection of a circuit calling at such points as its business may require.

If the circuit, when erected, can be used for other purposes than those of the department concerned in its erection, well and good; if not, further arrangements must be made. As a means of facilitating the business of any one department, such an arrangement is eminently practical and businesslike, but since the different circuits so erected do not all centre in one place, and are not arranged for inter-connection, the full value of the circuits in obtaining communication between *all* points

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provided with telephones is not always obtained even in "local" working.

As an instance of the results accruing from the unchecked individual selection of routes and calling points to suit special work, without co-operation for the greatest possible utility, consider the case shown in the diagram, Fig. 1, which may be taken as an actual example. Within a radius of a little over a mile there are 70 telephones installed on 21 circuits, the number of telephones on a circuit varying from two to nine, and the number in any one room from six to one. The arrangement of the instruments in any room is such that in few cases can conversation be carried on simultaneously by two persons in the same room without great inconvenience and discomfort. Besides this, no circuit is capable of being connected to another circuit, and any interchange of business between officials on different circuits must be done by transmission, where this is possible by the two circuits meeting at some common point. If circuits do not meet, then communication is not possible, though *both* are provided with telephones. An examination of the diagram shows that something very like a special training is needed for an official in one department to discover how he may communicate with another with the least amount of trouble to himself. Add to this the amount of ringing resulting in any room where a number of telephones are fixed, or in any office connected to a circuit with a number of other stations on it, and one ceases to wonder at the unanimity with which the higher officials determine that telephonic communication is more important for their subordinates than for themselves. Perhaps, not the least apparent defect shown by the diagram is seen in the number of points connected with the town exchange.

To the writer it has always appeared that the best method of arranging the telephone circuits of a railway consisted in an adaptation of the exchange system in use for the public service, in which all the "local" circuits at any centre would meet at a common point and be arranged to allow of connections being made between the different circuits as might be necessary. Such circuits need not be, as in the public service, connected to one point and the exchange only, as, in railway work, the need for strict privacy does not exist to the same extent. Such circuits might, as now, consist of three or four stations, communication between which might be carried on independent of the exchange, and attention called by such codes of signals as are now in use. When communication was required between points on different circuits, the connection would be made by the exchange, who would restore the circuits to their usual arrangement when the communication was finished. Such arrangements could not fail to have the most beneficial results on the working of the traffic and the making of detail arrangements, and, besides, would effect a considerable saving in the number of instruments required, and, by reducing the annoyance consequent on the constant ringing of a number of bells in an office, would do much to make the telephone more popular in quarters where it is at present looked upon as an unmitigated nuisance.

If Fig. 1 is contrasted with Fig. 2, which is the telephone system of Fig. 1 as it could be arranged and worked on the exchange system, due regard having been paid to circuits required for extra special purposes, a marked difference will be noted. The total number of instruments required is now only 47, or nearly 33 per cent. less than with the existing arrangement, whilst, in striking contrast to the arrangement shown in Fig. 1, every official provided with a telephone is capable of being put in direct communication with every other official similarly provided, and each telephone on the railway company's exchange is capable of being connected to the town exchange, although only one connection is needed instead of three as before.

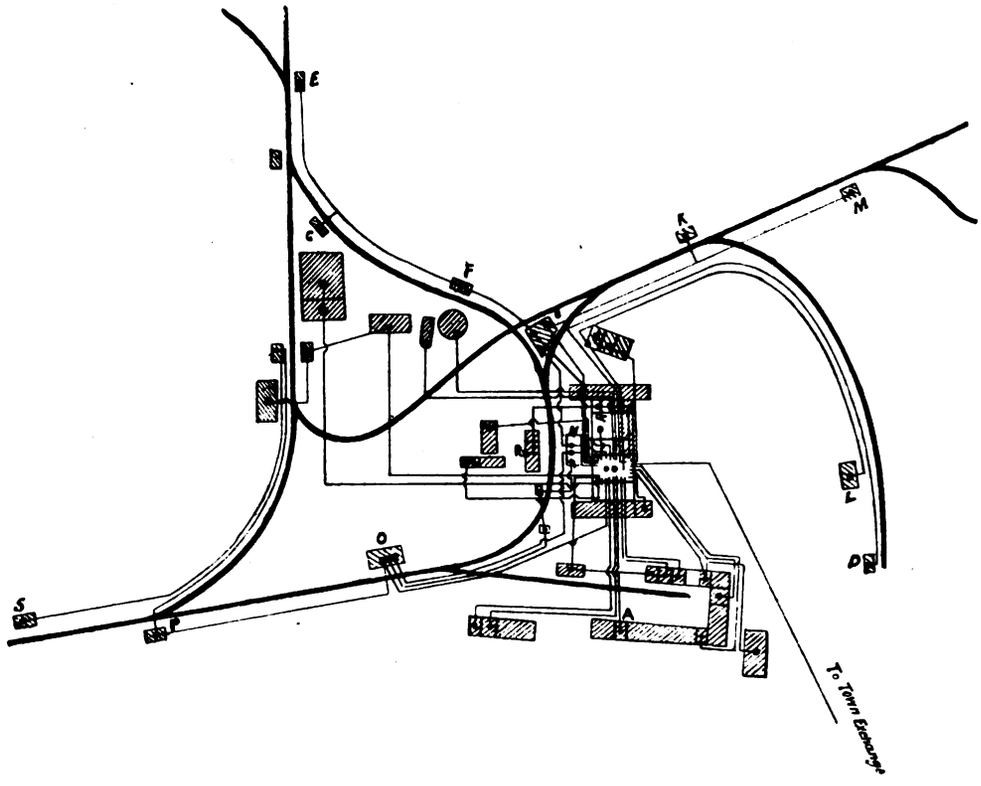

FIG. 2.—Telephone Circuits, Arranged for Complete Inter-communication.

A further application of the exchange system to "departmental" and "inter-departmental" working would be effected by the erection of trunk wires between the headquarters of the divisional superintendents. Each trunk wire would terminate in the local exchange at each end, and would be available for connecting together any of the circuits at those places. By judicious selection of the routes of the trunk wires all the divisions might, as shown for a particular case by Fig. 3, be brought into telephonic connection without much trouble or expense. By these arrangements railway managers would be provided with means of communication such as have never yet been available, either by their telegraph or telephone systems, and the organisation of the latter on some such basis as that outlined would do much to relieve the former from its present congested condition.

All this is, of course, very elementary and common knowledge, and the managers of telephone systems are entitled to smile complacently on reading of the direction in which the railway telephone service is trending, yet the

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fact that such a state of things exists is sufficient apology for calling attention to it. Every year of delay will add to the intricacy of the service and increase the expense of reorganisation when the present system has become intolerable. Such an arrangement, or rearrangement, as that suggested will never be obtained under the existing method of procedure, since the officials of the different departments are naturally most interested in their own business, and not fully cognisant with the requirements of or what is being done by their colleagues in other departments. It is therefore necessary that the work of organisation should be undertaken by some independent official who could consult with all parties as to their requirements, and who, having knowledge of all that was being done in that direction, would be able to concentrate the whole to the best advantage. Such official would naturally be the company's electrical engineer, since he is concerned in the erection of all circuits, and he alone has knowledge of all the arrangements being made. From his advantageous position the electrical engineer would be able to arrange the circuits to a maximum of efficiency at a minimum of cost, and, as will be seen from the foregoing, it is very desirable that he should have a freer hand in making circuit arrangements.

The great bugbear of railway telephony is caused by the complex phenomena which, whilst comprising the action of neighbouring circuits, earth currents, magnetic changes, atmospheric changes, and the distortion of the earth's field

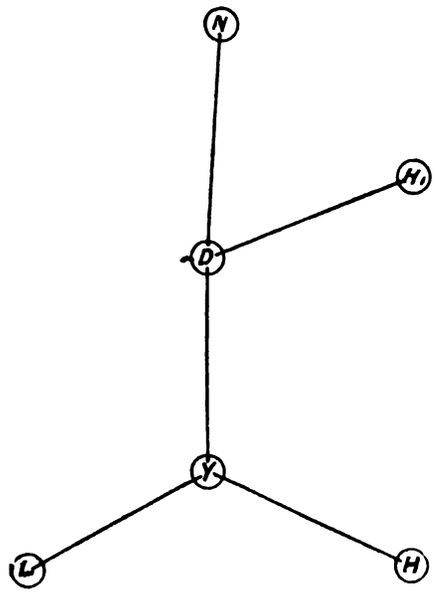

FIG. 3.—Arrangement of Trunk Wires.

by rapidly-moving large masses of iron at varying distances in the vicinity of the wires, are all summed up in the general term "inductive disturbance." This disturbance, whilst at all times annoying, becomes on some lines, and at certain times of the day, so great as to almost prevent the use of the circuit. In the early days of telephony, railway officials were so delighted with the ease and speed of working that a comparatively small defect such as this was overlooked or condoned in consideration of the numerous other advantages the instrument possessed over those to which they had been previously accustomed. With greater familiarity and more extended working the defect made itself more apparent, and the complaints on this head are now frequent and plain.

Whilst much may be done by intelligent adjustment of the instruments, yet the only remedy worth the name consists in doubling the circuits and twisting the wires. Railway electrical engineers have, with some exceptions, been somewhat tardy in recognising the need for these special arrangements, and some are said to look with grave displeasure on any proposal to double any troublesome circuit, to say nothing about twisting the wires. Whether this disinclination arises from a desire to preserve the geometrical symmetry of the wires on their lines, known as the "regulation," or to some other reason, it is nevertheless certain that they will in the near future be obliged to bring themselves into alignment with their more advanced *confrères* on this matter.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXIV.

(Specially Contributed.)

Hot-Wire Voltmeters.—A pretty experiment that is frequently shown is to take a conductor of wire made of alternate pieces of copper and platinum. When the circuit is completed the platinum sections of the conductor soon rise to a red heat, thus giving visible evidence of the heat-producing properties of an electric current. The platinum sections, if of the same length and sectional area as the copper sections, have a much higher resistance than the copper sections, and it seems as if this heat is generated and radiated at the sections of high resistance. This is not so: it is generated and radiated at all parts of the conductor, but the temperature of the part of higher resistance increases much more rapidly than the temperature of the part of lower resistance. Suppose, instead of alternate sections of the same length, we took alternate sections of the same resistance, then the same amount of heat would be generated in each section; but we shall not get the same visible results, for the surface area of the mass of copper which has the same resistance as a section of platinum is very large compared with the surface area of the platinum. The larger the surface area the larger the area for radiation and the less the rise in temperature. The temperature rises till the heat radiated equals the amount of heat generated. We have found by experiment that a current of an ampere through an ohm resistance produces 0·24 heat unit per second—that is, each ohm of wire will heat 0·24 gramme of water through 1deg. C. per second, which is about 0·13̇ of a gramme through 1deg. F. per second. If the current is doubled the heat generated is *four* times as great, for the heat generated is proportional to the square of the current, hence

1 ampere through 1 ohm gives 0·24 heat unit per second;
2 amperes through 1 ohm give 4 × 0·24 = ·96 heat units per second;
3 amperes through 1 ohm give 9 × 0·24 = 2·16 heat units per second.

The heat generated is directly proportional to the resistance, hence doubling the resistance means doubling the heat generated.

1 ampere through 1 ohm gives 0·24 heat unit per second;
2 amperes through 1 ohm give 4 × 0·24 = ·96 heat units per second;
2 amperes through 2 ohms give 2 × 4 × 0·24 = 1·92 units per second.

Hence we may use the formula,

$$\text{Heat generated} = 0{\cdot}24 \times C^2 \times R \times t \text{ heat units,}$$

where C = current in amperes;
R = resistance in ohms;
t = time in seconds.

The Calorimeter.—The apparatus used for determining the heat generated in a wire carrying a current is

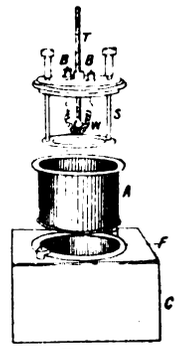

FIG. 1.

called a calorimeter. Fig. 1 shows the apparatus. Many precautions, of course, and great care have to be taken to obtain accuracy. The wire, W, is placed in the vessel, A, containing a badly-conducting liquid, such as refined coal-oil, or alcohol, or water. The current is conducted to W

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by the binding screws, B B. The voltage between B B is measured, as is the current, and, knowing these, the resistance of W is easily found. T is a thermometer to show the rise in temperature, and S is a stirrer to mix the liquid and obtain uniform temperature. The vessel, C, containing the liquid is placed in a felt wrapper, F, and this again in a box filled with loosely-packed sawdust or similar non-conducting material to prevent loss by radiation. Suppose vessel A and stirrer, S, of brass, and to weigh 200 grammes. It requires 0·093 heat unit to heat one gramme brass 1deg. C., so to raise vessel and stirrer 1deg. C. requires $0{\cdot}093 \times 200 = 18{\cdot}6$ heat-units. If A contains x grammes of water, and temperature rises T degrees in t seconds, then x T heat units have been given to the water, and the total heat generated is $18{\cdot}6\,T + x\,T$ units.

If the formula given above is correct, then

$$0{\cdot}24\,C^2 \times R \times t = 18{\cdot}6\,T + x\,T.$$

The heat unit above taken may be called the gramme-degree, and it takes 424·5 of these to make a unit = a gramme-metre—that is, one gramme lifted the height of a metre, which is a work unit often used instead of a foot-pound. We have seen that 33,000 foot-pounds per minute, or 550 foot-pounds per second, are equivalent to 1 h.p., and 76 kilogramme-metres per second are also equal to a horse-power; hence, whether we use the gramme-degree Centigrade heat unit, or the pound-degree Centigrade, or Fahrenheit, we can get the horse-power. If our unit is the heat required to raise 1lb. of water from 0deg. C. to 1deg. C., then the constant 0·24 given above must be changed to 0·0315, and the formula written

$$\text{Heat generated} = 0{\cdot}0315\,C^2 \times R \times t \text{ heat units.}$$

According to Joule the mechanical equivalent of heat is, using C. degrees, 1,390 (Prof. Ayrton in order to get round numbers, I suppose, uses 1,400), so that

$$W \text{ (foot-pounds)} = 1{,}390 \times 0{\cdot}0315\,C^2 \times R \times t;$$
$$= 43{\cdot}78\,C^2\,R\,t \text{ (say, } 43{\cdot}8\ C^2\,R\,t).$$

But

$$C = C\,\frac{E}{R};$$

so that we can write $= 43{\cdot}78\,C\,E\,t$ (say, $43{\cdot}8\,C\,E\,t$).

(If 1,400 is used instead of 1,390 then 43·8 will become 44·25, which is more incorrect, because 1,390 is nearer the truer number, 1,389·6, than is 1,400, and there is no use to be more incorrect than the nearest whole number.)

Example.—Suppose a wire having a resistance of one ohm carries a current of 10 amperes, what is the loss in horse-power?

Heat units generated and lost (radiated) per second $= 40{\cdot}2 \times 10^2 \times 1 = 24$.

Work units (gramme-metres) per second $= 24 \times 424{\cdot}55 = 10{,}189{\cdot}2$.

10,189·29 gramme-metres = 10·1892 kilogramme-metres.

76 kilogramme-metres per second = 1 h.p.

$$\therefore \frac{10{\cdot}1892}{76} = 0{\cdot}134 \text{ h.p.};$$

that is, 0·134 h.p. is lost by the dissipation of energy in such a wire.

If the current was 30 amperes instead of 10 amperes, the loss would be not *three* but *nine* times as great; because the loss, or the heat generated, varies as the square of the current.

Example.—If four amperes flow through a resistance of 4½ ohms for 20 minutes, how many foot-pounds of work are done?—(Ayrton.)

Prof. Ayrton gives the formula,

$$44{\cdot}25 \times C^2 R;$$

and the answer, 63,720.

According to the above the formula should be

$$43{\cdot}8\,C^2 R;$$

and the answer,

$$43{\cdot}8 \times 4^2 \times 4\tfrac{1}{2} \times 20 = 63{,}072;$$

the difference being caused solely and wholly by the approximation to 1,389·6 being taken in the first case as 1,400, and in the second, and I think the more correct, as 1,390. I call attention to this serious state of things, and especially from a student's point of view. The laxity of authors in choosing approximations should be regulated, and upon no account should a student lose marks because he uses another constant than that favoured by an examiner.

Expansion by Heat—All bodies expand when heated. It has been seen that a current passing through a wire heats that wire. Therefore the wire will expand. We need only trouble here about the linear expansion—that is, the expansion in length, or the elongation due to the heat. It is found that if a bar of iron, for example, be raised in temperature, its elongation per degree of temperature is very nearly uniform at all ordinary temperatures. Thus, if we take a bar of iron a foot long and raise its temperature 1deg. C., and carefully measure the elongation (call it x), the length of the bar at the higher temperature will be 1ft. $+ x$ the elongation. If we raise the bar two degrees its length will be 1ft. $+ 2x$; if we raise it three degrees, its length will be 1ft. $+ 3x$, and so on, if the temperature is raised n degrees the increase of length is nx.

The number representing the extension in length is called the coefficient of expansion. Thus if the coefficient of expansion of iron is 0·000012, then a bar of iron

1 foot in length raised 1deg. C becomes 1·000012ft. in length;

1 yard in length raised 1deg. C becomes 1·000012 yards in length;

1 mile in length raised 1deg. C becomes 1·000012 miles in length.

I need not repeat this at length, but one more example must suffice. If the bar of iron is raised 20deg. C. in temperature, then

1 foot in length raised 20deg. C. becomes

$$1 + 20\ (\cdot000012) \text{ feet in length.}$$
$$= 1{\cdot}000240 \text{ feet in length.}$$

Coefficients of Expansion for 1deg. C. (Kohlrausch).

Aluminium ...	0·000023	Brass	0·000019
Lead.....	0·000029	German silver ...	0·000018
Iron	0·000012	Platinum	0·000009
Glass	0·0000085	Platinum-iridium .	0·000009
Gold.....	0·000015	Silver	0·000019
Copper.....	0·000017	Zinc.....	0·000029
Vulcanite.....	0·00008	Tin	0·000023

Before leaving this table, let me just direct attention to the similarity between the coefficients for glass, platinum, and platinum-iridium, as, practically, advantage has been taken of this fact in the manufacture of incandescent lamps.

So far as instruments are concerned, it is easily seen that the elongation of a wire due to heat generated varies as the square of the current, and so can be used as a measure of pressure—that is, can be utilised as a voltmeter. No satisfactory ammeter has been made upon this principle. These instruments are used both for direct and alternate current circuits.

Cardew's Voltmeter.—Major Cardew was the first to take advantage of the heating properties of the current in the design of a voltmeter. If a wire, W W (Fig. 2), be

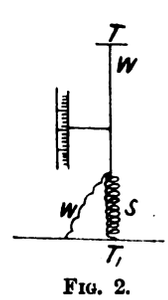

Fig. 2.

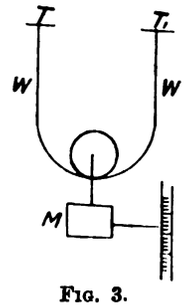

Fig. 3.

fixed as shown between the terminals, T T_1, fastened, say, to T_1 through a spring, S, and a current be sent through it, the spring will take up the elongation which will be shown by the pointer, P, on the scale. Another way of getting the elongation due to rise in temperature shown would be by an arrangement as in Fig. 3, where T T_1 are the terminals, W W the wire. The wire carries the weight, M, which, again, carries a pointer, P. Any extension of the wire is shown by the pointer on the scale.

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Do not forget the wire rises in temperature only so long as the radiation is less than the generation. The wire will not elongate when the radiation and generation are equal; but then its length is constant. Fig. 4 shows a form of Cardew's voltmeter. In it some 13ft. of platinum-silver wire, 0·0025in. in diameter, is stretched between the two terminals. Follow the course of the wire. Commencing at the screw terminal T, it

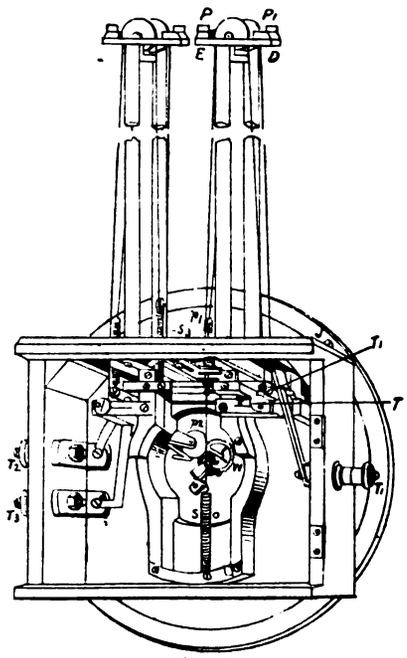

FIG. 4.

goes over pulley P, down under p, back over P_1, and down to terminal T_1. The pulley p is connected by a fine flexible thread, which goes once round the pulley p_2 to the spring, S. Thus the wire is kept stretched by the pull of the spring, S, and if it lengthens, the thread around the pulley p_2 turns the pulley which carries on its axle another toothed wheel, W, which works a pinion carrying a pointer. The terminals T T_1 are connected to outside terminals, T_2 T_3. The action of the current is to raise the temperature of the wire, which lengthens. The increase in length is taken up by the spring, which action turns the wheel p_2, the toothed wheel, W, and thus moves pinion and pointer. The movement of the pointer is shown on a scale on the face of the instrument. In the more recent instruments a duplicate wire is placed similarly to the one just described, and this second wire is so arranged that it can be placed in series with the first, so doubling the range of the instrument. The dial face in the instrument with a duplicate wire is graduated for two sets of observations—the one when one wire is used, the other when both are used in series. The fine wires are protected by tubes, and the whole apparatus encased to prevent errors from outside thermal influences. The scale divisions are made from experiment. It is hardly necessary to point out that it is the extension of one half of the wire only that influences the deflection of the pointer. It is not necessary to measure the extension of the whole wire, which would simply be twice or four times greater as one or both sets of wire were used. The extra length of wire used is to obtain resistance; this will be understood by referring back to what has been said about the resistance of ammeters and voltmeters.

The Acme Voltmeter.—This is another form of hot-wire instrument made in America. I am indebted to Mr. Wiener for the description. In Fig. 5, B_1 shows a fixed support to the wire, A, which at the other end goes to the phosphor-bronze spring, C. The wire, A, is 0·0012in. diameter and 6·5in. long. At D, midway between B_1 and C, it is connected to a phosphor-bronze strip rolled flat from a wire 0·0015in. diameter, which passes round the index shaft, E, engaging with the two pins, F F, attached to the collar, G, and on to the spring, S. The strip, D, is connected to A through a piece of glass as an insulator, which carries a platinum hook. It is easily seen that under a current A extends, and is bent by the pull of spring, S, through D. The pull is shown by the index. The two wires A_1 A_1 are the same length as A, but are not acted upon by the current. They serve an important function, however, in restraining C from taking up the expansion of A due to current, and allowing it to take up expansion from any other cause. In other words, they allow C to follow external changes of temperature, and thus com-

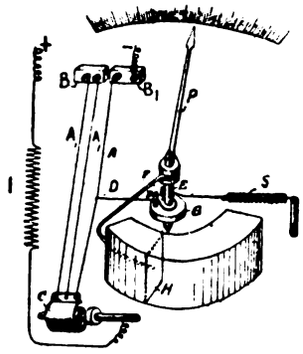

FIG. 5.

pensate for any deviation in the zero position of the pointer for varying temperatures. To make the instrument dead-beat, a vane, H, acting in an air-chamber, is attached to the pointer shaft.

Other instruments of this kind are made, but enough have been described to show how they work and the principle under under which they can be used as voltmeters.

THE STANDARDS OF LIGHT.*

BY W. J. DIBDIN, F.I.C., F.C.S., ETC.

(Concluded from page 159.)

The important point of uniformity was then tested. For this purpose Mr. Sugg was requested to make two dozen of the burners, which were distributed amongst members of the committee, who found that they all gave results practically identical with one another, showing that no difficulty will be experienced in producing a number of these burners suited to serve as standards.

In order to ascertain whether the burner first submitted was capable of modification so as to simplify its construction without affecting the constancy of the light emitted by the flame when at various heights, a number of experiments were made, with the result that the committee arrived at the conclusion that the 10-candle pentane-Argand would, with a slight modification, be in every respect a trustworthy standard when supplied with atmospheric air carrying the vapour of pentane supplied by the carburetter provided. The modification alluded to consisted in the substitution of a rectilinear for a curvilinear solid cone for greater convenience and certainty in measurement, and defining the distance at which it is to be fixed below the centre opening of the burner.

The following description of the 10-candle pentane-Argand air-gas standard, as recommended by the committee for use in gas testing, is given in Section IX. of the appendix to the report of the committee:

Description of Dibdin's 10 Candle Pentane-Argand Air Gas Standard, as recommended by the Committee for use in Gas Testing.—The apparatus used in producing this standard of light consists of two separate portions—viz., the burner and the carburetter. The burner is a specially constructed tri-current Argand burner, the annular steatite ring being perforated with 42 holes, each hole being 0·71 millimetre in diameter. The three air currents are: (1) the central current rising inside the steatite to the inner portion of the flame; (2) a current rising outside the steatite, and caused to impinge upon the flame by an inner metal perforated and incurved cone, the top of which is level with the top of the steatite; (3) an outer current rising on the outside of the above cone, and between that cone and the glass chimney. The inner perforated cone is punctured with 10 apertures 0·25in. in diameter, which are provided for the purpose of equalising the two outer currents of air as may be required to suit the height of the flame. The glass chimney is carried in the groove provided on the outer cone, which answers the purpose of a gallery, the dimensions of the chimney being 6in. high and 1½in. inside diameter. The top of the flame should be maintained as nearly as possible at 3in. above the steatite, this point being indicated by the wires crossing the blue glass screens carried on each side of the burner on the metal supports. The flame is steadied by the small air-directing cone situated centrally beneath the steatite, the apex being 0·03in. below the metal support carrying the steatite. On the side of

* Paper read before the Society of Arts,

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the burner to be presented to the photometer disc a metal screen 8½in. in height is placed and screwed securely to the base-plate. The middle portion of this screen is cut away, so as to leave above the top of the steatite burner an opening 2·15in. in height and 1·4in. in width, the lower portion of this opening being exactly level with the top of the steatite. The light emitted horizontally through this opening by the flame produced by the combustion of the gaseous mixture of atmospheric air and pentane formed in the carburetter described below is used as the standard of light. It is equal to the light emitted by 10 parliamentary sperm candles. The lower portion of the screen has an opening, 1in. wide by 2·3in. in height, to allow free access of air to the under portion of the burner. The various dimensions and arrangements of the parts are more particularly described in the following table of measurements. The position of the burner in relation to the photometer disc is to be fixed by the burner fitting gastight into a faced joint attached to the photometer at the required point; and the burner is to be set at such a height that the centre of the illuminated disc and the bottom edge of the cut-off shall be in the same horizontal plane. The length of the connection between the burner and the carburetter may be varied, but should not be more than 5ft. The centre of the flame is to be immediately over the terminal point of the photometer bar. The carburetter for the 10-candle pentane-Argand consists of a circular vessel constructed of tinned plate:

Diameter ..... 203·2mm. = 8in.
Depth..... 50·8mm. = 2in.

Having a spiral division 25·4mm. = 1in. in width. This division is made by soldering in a spiral strip of metal 4ft. 6in. in length and 2in. wide, gastight, to the underside of the top of the carburetter, so that when the top is fixed on the bottom of the strip comes close to the bottom of the vessel and is sealed by the pentane, so that the air has to pass over pentane for a distance of about 4ft. 6in., and becomes thoroughly saturated. At the end of the spiral division, near the side of the carburetter, a bird fountain is fixed for charging the carburetter and keeping it charged at a constant level with liquid pentane. The lower end of the inlet fountain tube is closed, and rests upon the bottom of the tank. Through the side of the tube, which is $\frac{4}{10}$ths of an inch (10·1mm.) in diameter, 16 holes 1mm. in diameter are bored close to the bottom, and through these the pentane enters the carburetter. At one side of the inlet tube, and 1in. from the lower end, a small tube 33mm. in diameter and 20mm. in length is connected thereto and turned upwards. The fountain inlet tube is carried up through the top of the carburetter, and continued in the form of a bulb having a capacity of about 200 cubic centimetres. Stop-cocks are provided at the top and bottom of the bulb for convenience in filling with pentane, and the portion above the upper stop-cock is opened out in a funnel shape for the same purpose. When the carburetter is being charged, the gas must be extinguished to avoid the risk of the vapour firing and causing an explosion. The inlet for gas or air is at the side of the carburetter, and at one terminal of the spiral division, the outlet being placed in the centre of the vessel, so that the air or gas may travel over the liquid pentane throughout the whole length of the spiral division, and thus become fully charged with the volatile vapour of the pentane. When using this standard, the pentane must be visible in the fountain bulb.

Measurements of Mr. Dibdin's 10-Candle Pentane-Argand Burner.

Number of holes	42	
	mm.	in.
Diameter of holes	0·71	= 0·028
Inside diameter of steatite	9·90	= 0·390
Outside diameter of steatite.....	19·05	= 0·750
Diameter of inside of metal cone at top	23·62	= 0·930
Chimney length.....	152·4	= 6·000
Chimney inside diameter.....	38·1	= 1·500
Height of cut-off	54·61	= 2·150

The centre of the flame to be immediately over the terminal of the photometer bar.

This form of standard has been modified so as to yield a light of one or two candles, as desired; also 16 candles. In the case of the burner yielding one or two candles, as required, the flame may be used in two ways, either with or without the screen, or "cut-off." If without the screen it is equal to 1·0 candle when the flame is 1·25in. in height, and to 2·0 candles when 2·30in. in height. In either of these cases, of course, there is no "allowable variation" in the height of the flame. When the screen is employed, however, the value of one candle is obtained, when the screen is set 0·92in. above the burner, and the height of the flame is kept within from 1·5in. to 2·0in., thus having an allowable variation in height of ½in. The value of 2·0 candles is obtained when the screen is set 1·64in. above the burner, and the height of the flame is kept within from 3in. to 4½in., thus having an allowable variation of 1½in.; the chimney employed with this standard being 4·5in. by 1·25in. inside measure.

The term "allowable variation" is used merely to indicate the tolerance of the burner in unskilful hands, so that if by a mistake or error of judgment the height of the flame is not fixed to the mean point, but is anywhere within the limits of the allowable variation, the results will not, for all practical purposes, be vitiated. In exact work, however, it is always to be understood that the height of the flame should be that indicated in each case as the mean of the "allowable variation"—viz., with the one-candle screened flame, 1·75in.—and with the two-candle screened flame, 3·75in. In like manner, the allowable variation of the 10-candle pentane-Argand is from 2·5in. to 5in., and that of the 16-candle pentane-Argand from 3·5in. to 7in.

The pentane employed to produce the air-gas used in Mr. Harcourt's one-candle standard, and in the carburetter of the 10-candle pentane-Argand, was obtained by purifying light petroleum by the successive action of sulphuric acid and soda solution, and then distilling at 60deg. C., at 55deg. C., and twice at 50deg. C. It was, however, considered important to obtain samples of pure isopentane from other sources in order to ascertain if the air-gas prepared from them would give the same amount of illumination as with the normal pentane. For this purpose a sample of so-called pure isopentane was obtained from Berlin, but on examination proved to be unsatisfactory. Accordingly, Prof. T. E. Thorpe was requested to have a sample of pure isopentane prepared. This task he kindly undertook, and with the assistance of Mr. A. Greeves three specimens were made and submitted to the committee. The method used was, shortly, as follows: The mixture of active and inactive amyl alcohols, obtained by the purification of fusel oil boiling from 120deg. to 132deg. C. under a pressure of 760mm., was converted into a mixture of iodides, which was then reduced to isopentane by means of the zinc-copper couple. Three samples were thus prepared from German, Scotch, and Irish fusel oils, all the conditions being strictly comparable. These were handed to the committee and experimented upon both with the one-candle pentane flame and the 10-candle pentane-Argand. In the case of the former it was found that rather more light was yielded by the isopentane than by the normal pentane obtained from petroleum. In the case of the 10-candle pentane-Argand, however, identical results were obtained with either sample, this, doubtless, being due to the remarkable compensating action of the flame yielded by that burner in a manner similar to the compensating action which takes place when air is replaced with coal-gas as the medium for driving forward the vapour of the liquid pentane in the carburetter. This result points to the conclusion that the pentane-Argand enables either of these combustible materials to be employed without any practical difference in the amount of light passing under the screen and employed as a standard; hence, should there be at any future time a suspicion that commercial pentane has altered in respect of its illuminating value, it can always be standardised by an appeal to the light of the pentane-Argand burner fed with air carburetted with pure isopentane.

An important question having been raised by Mr. John Methven as to the effect of the humidity of the atmosphere upon the amount of light emitted by a luminous flame, the committee gave the matter very careful consideration, and a prolonged series of experiments was undertaken by the secretary, Prof. Vivian B. Lewes, F.I.C., to elucidate the matter.

Mr. Methven had found that when the temperature was practically constant, candles gave per 120 grains of sperm consumed a light equal to 1·104 as compared with a constant source of light (Methven screen), and that this was increased to 1·196 when the air in which the candles were burning was dried. This difference in the light value he considered to be due entirely to the removal of the moisture, as the temperature remained the same. He also found that when air saturated with moisture at increasing temperatures is supplied to a flame, the light value rapidly diminished, so that between the temperatures of 50deg. F. and 75deg. F. a diminution of 10 per cent. takes place in the light emitted by an Argand flame burning five cubic feet of gas per hour, while with a flat flame a reduction of 12·2 per cent. took place, and with a gas flame from a two-candle burner a loss of 13 per cent. was found within the same range of temperature.

Mr. Methven ascribed these differences to the different power of the flames to battle with the aqueous vapour. The result of the committee's experiments was that, although by abnormally saturating or drying the air supplied to a flame, variations as great as those obtained by Mr. Methven undoubtedly occur, yet that in a well-ventilated testing-room, with the temperature kept within a narrow range, no such great differences are to be found. These conclusions were also supported by the experience of Mr. Vernon Harcourt, Mr. Greville Williams, and Mr. W. C. Young; and it did not therefore appear to be necessary to take this otherwise important point into consideration in connection with the enquiry, especially as the value of the standard recommended was so close to that of the light to be tested, and thus any variation in the one would be balanced by that in the other.

In view of the definite results obtained the recommendation of the committee to the effect that the gas referees should be authorised, should they at any time see fit, to approve and certify for gas-testing any other flame based upon the 10-candle pentane-Argand would appear to be unnecessary, as opening the door to alterations from time to time, and thus again reopening the question which all desire so earnestly to see settled. The provision, however, that no alteration should be so made without the sanction of the Board of Trade and the gas companies would provide a safeguard against any interference with the standard on trivial grounds, is well advised. But undoubtedly the other parties to the contract—viz., the controlling authorities, as representatives of the public—should be equally repre-

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sented with the gas companies, and doubtless this will be provided for in any Act legalising the present proposed alteration. In that case no objection can be raised to the clause, and the advantage gained would be that in case the advance of knowledge should place at the hands of the operator a still more convenient and reliable process, it would not be necessary to incur the delay and expense of another Act of Parliament, the needful authority for the change being merely a notification of the gas referees to that effect.

In this connection I have much pleasure in calling attention to a form of 10-candle pentane burner proposed by Mr. A. Vernon Harcourt, in which the pentane is burnt after the manner of petroleum, in that the vapour is raised to the metal burner by the agency of a cotton wick, the air supply being admitted to the burner from outside as in the case of the P_2 one-candle lamp of that gentleman. With reference to this suggestion, I am unable to speak in the absence of experience with it in practice; but whether in regard to this or any other method which may be proposed hereafter I have only one wish, and that is that the public should have the benefit of the best available means of producing a standard light, and that whenever a better system than the pentane-Argand is found I shall be one of the first to advocate its use. Sixteen years ago I advocated the adoption of the Keats lamp; seven years later I found that the Harcourt one-candle standard gave better results in the hands of various operators than the apparently more delicate Keats system, and I used my best endeavours to obtain its adoption. Now that it is universally admitted that the pentane-Argand which I have since elaborated so as to provide a good working instrument as well as an accurate standard is by far the most desirable form, if not the only practical one acceptable to all parties, I desire that its use shall be legalised; and that, in order that there shall be no "dog-in-the-manger" policy, the machinery should be provided by means of which any improvement of the present best-known method may be legalised without the cumbrous "Act of Parliament" having to be called into requisition.

To many it may seem to be a matter of regret that the question of the method of burning the gas to be tested should have been imported into the question, as tending to complicate the simple question of the standard of light, especially as it is a question of how far any benefit would arise to the public generally by such a change—the possibility, indeed, being that it would tend solely in favour of the sellers of gas rather than the users. As, however, the gas companies were urgent in representing the desirability of this point, as appears from the notes of the interview which the committee had with the representatives of the Incorporated Institution of Gas Engineers and the Incorporated Gas Institute, such an alteration as proposed—viz., "That the requirement that the gas shall actually be consumed at the rate of five cubic feet of gas be rescinded, so as to allow the gas referees to sanction a mode of testing in which the gas shall be burned at whatever rate is found requisite, in order that it may give a light equal to that of the prescribed number of candles;" or, in the words of the gas representatives, "that the rate of the consumption of gas to be tested be adjusted as nearly as practicable to the maximum efficiency of the various standard burners"—does in effect upset the existing bargain between the gas companies and the public, as repeatedly sanctioned by Parliament. The simple substitution of a reliable for an unreliable standard is a question which does not affect the existing contract, whereas the committee afford no evidence of an experimental character to warrant the further change thus proposed.

Having thus fully considered the most recent work in this connection in England, it will not be without interest to discuss the most modern work on the Continent on the subject. This is contained in the report of the Dutch Gas Association on photometry which was issued in 1894. The report is an able and exhaustive account of a special enquiry upon the whole question of photometry as applied to the estimation of the illuminating power of coal-gas, and especially so with regard to the standard of light. After a careful *résumé* of the work hitherto accomplished in this direction, the committee of the association arrived at the conclusion that none of the existing proposals met all the requirements of an ideal standard, and, consequently, proceeded to devise a method which they considered fully answered all purposes. It is to be noted that their report contains no reference to the pentane-Argand, which does not appear to have attracted their attention, although it has now been before the public for nearly 10 years, but in a less prominent form than it has now assumed in consequence of the work of the Board of Trade committee.

The lamp designed by the Dutch Association is based upon the one-candle pentane lamp, known as the P_2 lamp, of Mr. Vernon Harcourt, in which that gentleman employed the device, first introduced by myself, of cutting off the top portion of the flame by means of a screen, in a similar manner to that employed in the pentane-Argand. Instead of using pentane for the fuel a mixture of 9 of benzol to 100 of sulphuric ether is preferred. Experiments showed that between 7·7 and 11·2 parts of benzol the effective variation of the light is only 1 per cent.; whilst between 8·5 and 10·2 parts it is only 0·1 per cent., and the light is therefore practically constant when the benzol varies between 8·5 and 10·2 parts to 100 of ether. This mixture, made up with ether of specific gravity of 0·7215 and benzol of specific gravity of 0·886, had a specific gravity of 0·7335, all at 15deg. C.; but it was found that after 33 per cent. of the contents of the reservoir had been burned away, the residue retained exactly the original specific gravity of 0·7335. The mixture had, therefore, evaporated as a whole, and could thus be used as a standard fuel for the lamp. Various experiments with pure and impure ether showed that no difficulty could be experienced in daily work from casual impurities, although pure ether is recommended for use in standard instruments. Using this arrangement as a standard the Dutch Committee found that the amyl-acetate lamp = 0·9213 candle, = 0·8333 German candle; the English candle = 1·0854 amyl-acetate lamp, = 0·9045 German candle; German candle = 1·2 amyl-acetate lamp, = 1·1053 English candle. Three specimens of the carcel lamp were tested with the average result that the carcel is equal to 9·631 English candles, which agrees with the Kirkham and Suggs's experiments in 1869, who found the carcel to equal 9·6 candles; and the tests made by myself, in 1885, when comparing it with the Keats lamp, the result being 9·61. A series of tests against the one-candle pentane air-gas flame made at the same time as those with Keats's lamp gave a mean result of 9·35, which, however, corrected for the method of setting the pentane then employed, as above described, by the factor 2·59 per cent., a correction only discovered seven years later, gives a result equal to 9·63. These remarkable coincidences of the results of different observers at widely different periods, and by equally widely different methods, are not a little satisfactory in many respects, and serve to show the nature of the work which can be accomplished when a sufficiently large number of experiments are made to eliminate the accidental errors due to isolated tests.

From the above *résumé* of the position of the question of providing a substitute, acceptable to all parties, for the present legal candle, it will be seen that all that remains to be done is for Parliament to sanction the proposed change; and by thus legalising the pentane-Argand bring to a conclusion a question which has gradually ripened until it would seem as if the last word had been said; and there is nothing to delay the closing scene by parliamentary action. Sufficient time has elapsed since the publication of the report of the committee for thorough trial of the new standard, and there should be now no question as to the result. It is to be hoped that the discussion of the facts which I have ventured to place before the society will be such as to strengthen the hands of the Board of Trade when dealing with the matter during the ensuing session of Parliament.

DISCUSSION.

Mr. A. Vernon Harcourt, F R S, said he could add but very little to what Mr. Dibdin had said; for if he had been asked to give a paper on this subject, having in his recollection the work of the committee on which both Mr. Dibdin and himself had been engaged for two years, it would have borne a great likeness to the one they had heard; and there were only one or two points on which he should wish to make any addition. Perhaps it would have been wiser if the committee had limited itself to the matters referred to it, and only made a recommendation as to the standard of light; but it did make a recommendation as to a nearly related subject, which affected the actual use of the standard in testing the illuminating power of gas. The recommendation was that, instead of the gas being tested at the uniform rate of five cubic feet per hour at the standard burner which had been prescribed for testing purposes, it should be burned at such a rate as would give from that burner a uniform light of 16 candles. Working in that way the test might still be regarded as giving the illuminating power of the gas by assuming that the quantity of gas required to give a certain amount of light varied inversely with the quality of the gas. That was substantially true; and if the recommendation were adopted there would be the advantage that the quality of the gas would be judged precisely from the consumers' point of view. Such a mode of testing would correspond more nearly than the present, with the effect on the consumer of a variation in the quality of gas, and it would do more justice to those who supplied it. He would add that he personally tried some of the experiments with Mr. Dibdin's burner and found that under widely varying conditions the amount of light given out in the photometer was practically constant.

Mr. J Methven said he had been watching the behaviour of this pentane standard of Mr. Dibdin during the last few months, and had compared it against candles. He had had half a dozen operators at work, who had made 500 separate experiments, and it was found, as the result of the average, that the power of the burner was equal to 10·283 candles. Of course it ought to be equal to 10, and he was glad to have the opportunity of stating the result of these experiments, because, naturally, an increase of nearly 3 per cent. on the 10-candle was almost equal to half a candle on 16-candle gas, and inasmuch as the extra enrichment of half a candle would cost the gas companies of London about a halfpenny, it was obvious how they would be affected by that additional value being put on the standard. It seemed rather hard on gas com-

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panies to have to submit to the introduction of a standard which was nearly 3 per cent. higher than the result of experiments on 500 candles. Mr. Dibdin seemed rather to regret that the committee had introduced any alterations in the mode of consuming the gas to be tested, but he thought they had not gone far enough, because one very important matter in settling the question of these standards was to determine the photometer in which they were to be used. Without casting any reflection on the manner in which the committee made their experiments, he thought the importance of the subject required that further investigation should be made before a new standard was introduced.

Mr. J. Cadett said he had used the pentane-Argand, both the 2 c.p. and the 10 c.p, during the last two years as a standard for photographic purposes. In such cases they did not expect to work to three places of decimals of a candle, but as far as they could observe, using ordinary care, they were quite unable to notice any difference in testing with the pentane-Argand.

Mr. Lloyd said that everyone was interested in having a thoroughly reliable standard, but he held that it was better to take the improved standards as they were invented than to defer giving up the candles until perfection had been reached.

Colonel Allan Cunningham, R E., thought they had had brought before them a standard of light which he hoped would have a wider use than the testing of pure gas only. It might be used to test the illuminating qualities of petroleum, etc., or for photographic exposures or other scientific purposes. He thought that in testing this standard burner more attention should have been paid to the effects of varying pressure of the atmosphere. This could be ascertained by comparing the burner with an incandescent lamp, which, being enclosed, was not affected by change of pressure.

Mr. Campbell said that the effect of the presence of carbonic acid in the air had not been touched on. From experiments in Germany he believed that the influence of CO_2 was great. The addition of 1 part in 1,000 made a difference, he believed, of 7 per cent. in the amylacetate standard.

Mr. Grafton referred to some former experiments of Mr. Dibdin, which seemed to show that his light was equal to 16·7 candles by Mr. Harcourt's one-candle standard and Mr. Methven's two-candle standard. He personally had conducted some 3,000 tests, and could not get it to average 10 candles.

Mr. Lacey said he had used this standard ever since it was first mooted in his ordinary daily work, and had found it very convenient and accurate. He thought the accuracy and uniformity of more importance than any small error in actually candle-power. He preferred a 10-candle standard to a 16-candle one.

Mr. C. E. Hearson asked if pentane could be readily obtained, and whether there would be any difficulty with regard to its carriage, on account of its inflammatory nature.

Mr. Dibdin, in reply, said he had found no difficulty in procuring pentane, and it generally came by carrier, as it was no more dangerous than ordinary benzolene or ether, and many other things which were systematically conveyed about the country. Taking the points raised in order, Mr. Methven said an average of 500 experiments gave a value of 10·283 candles for this standard. Against this he had to place his own experiments, which numbered about 2,000, and those made by the members of the committee and others must have amounted to about 10,000, so that there were about 12,000 against 500. He could not cavil at Mr. Methven's results, but an average derived from 10,000 or 12,000 experiments must outweigh an average of 500. The question of photometers could now be settled without going to Parliament, because the referees had full powers, and he believed it was understood that when the standard was settled the referees would once for all prescribe the photometer. His own experience was that if a photometer were well ventilated it did not matter whether you had a bit of wood at the back or a velvet curtain, or something in front or at the ends, so long as you screened the eye of the observer from lights and avoided reflection from extraneous surfaces on the screen. The cabinet work did not matter. He preferred to burn lights in the open, but it did not matter much; but to surround your lights with upholstery did not seem to him the best way of doing it. When you had candles burning in a heated box, with insufficient ventilation, you could make them do whatever you liked. That was exactly what has been done in some of the experiments referred to by Mr. Methven. In some of his results he got an average of 16·3 as the value of a certain flame with the Methven two-candle screen and the Harcourt one-candle pentane flame, as against 17·0 as an average of all the results with candles. But that average of 17 0 was raised by including certain results which were obtained in a room purposely heated to a temperature of over 90deg., and the candles behaved in such a way owing to the rapid volatilisation of the sperm that they began to smoke, and gave less light. Thus the value of the gas consumed was made to appear higher, and in many cases the 16·3 average flame, when tested by the candle, appeared to be up to 18 or 19 candles. In taking the average he excluded all those results which came over 17·5. Thus, the Harcourt lamp and the Methven screen agreed, and the candles, including tests which were obviously incorrect, gave results 0·4 too high. He was obliged to Mr. Cadett and Mr. Lacey for their support. Colonel Cunningham seemed to have an idea of carrying a standard of light all over the world, which was a grand idea, but the committee of the Board of Trade recommended the adoption of this standard simply as a working standard for testing London gas, not as an absolute unit of light to be used everywhere. What would be the variation at an elevation of 7,000ft., or down in a mine, he had not had an opportunity of trying, but Mr. Vernon Harcourt had made some experiments with the one-candle unit on the tep of Ben Nevis against the light of an incandescent electric lamp, and he believed that the variation was very little, if any. If that were the case, probably the same result would be found with the 10-candle standard, as the same argument applied. The effects of dust and fog were eliminated to a great extent by the fact that the distance between the standard and the light to be tested was usually very small, so that the fog would have to be very considerable before any readable difference would be introduced. Mr. Grafton also raised the point that his chimneys were not always nicely ground at right angles, but if anyone choose to purchase something which was not what it ought to be, they must take the responsibility. He was glad to hear Mr. Lacey recognise the fact that the committee had done their best to arrive at a practical solution of the question. He thought the tone of the meeting was such as to justify the decision at which the committee had arrived.

The **Chairman**, in proposing a vote of thanks to Mr. Dibdin, said anybody who had ever had to work at photometry with candles would agree that the sooner this standard was got rid of the better. He hoped the discussion might help to educate members of Parliament, so that they might soon have a satisfactory standard for testing London gas.

The vote of thanks was carried unanimously, and the meeting adjourned.

ALTERNATE-CURRENT TRANSFORMERS.

BY DR. J. A. FLEMING, F.R.S.

The last lecture of the set of four on the above subject was delivered on Monday, and Dr. Fleming found a difficulty in completing the range of the syllabus in the limited time at his disposal. The details of testing transformers were not quite completed in the last lecture, so the measurement of the resistances of the copper circuit was the first subject referred to. Dr. Fleming advised that, when measuring the resistance of the primary winding with a Wheatstone bridge, the secondary circuit should be short-circuited to reduce the self-induction effects. He also recommended that the low resistance of the secondary windings should be measured by the potentiometer method. The measurement should be made both when the transformer was cold and also after a long period of load. The variation of resistance would then give a good indication of the actual temperature rise in the body of the transformer. Having obtained thus the copper losses and also the iron loss, a curve of total loss at any load could be constructed which would be useful in computing the all-day efficiency of a transformer with a given load curve. The lecturer went back to the subject of fall of potential on full load. He explained that the total loss of pressure was made up of two components—*i.e.*, the copper drop and the drop due to magnetic leakage. The following diagram shows an excellent method of determining the total drop, but it necessitates the use of two transformers. As will be seen, it is a differential method, and

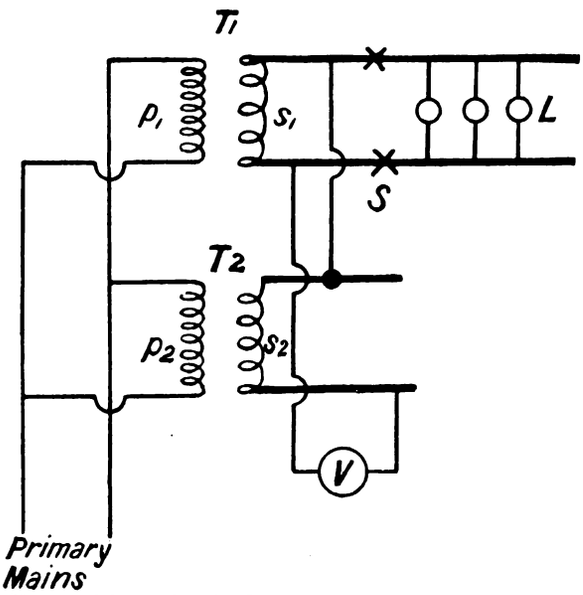

Diagram of Connections for Testing Total Drop in Transformers.

hence a small alteration in the pressure on the mains will not affect the reading much. The voltmeter used must be an electrostatic one, and must be capable of reading from one volt upwards. A delicate electrostatic instrument designed by Messrs. Ayrton and Mather was recommended for the purpose. Referring to the leakage question, Dr. Fleming said that a mercury thermometer would give indications of magnetic leakage, as the eddy currents in the mercury would cause an apparently high temperature as compared with a spirit thermometer. The action of peaked E.M.F. curve was stated to increase the leakage effects, although the same curve tended to reduce the hysteresis loss. A few examples of the use of magnetic leakage to obtain a constant current from constant pressure were given by illustrations of the Thomson-Houston constant-current transformer,

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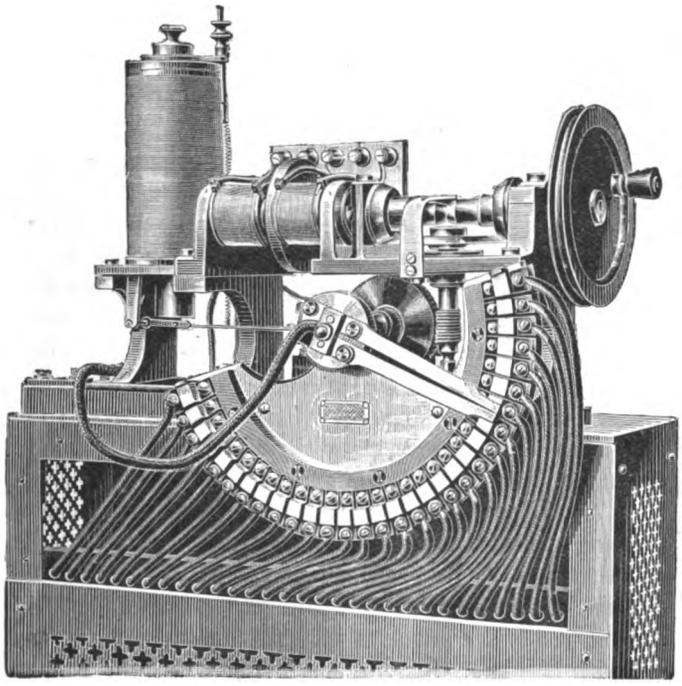
etc. The lecturer then dealt very briefly with the interesting subject of the alteration of the hysteresis loss with time. Unfortunately, the time at his disposal prevented him giving more than a few general remarks, from which no definite conclusions could be drawn.

The next subject—*i.e.*, that of resonance effects in alternating circuits containing capacity and self-induction—also suffered very much from the limited time. Some interesting analogies were shown, and from them the now well-known conclusions that no alternating-current circuit should be suddenly interrupted or made were discussed. Then, after briefly referring to the skin effect in large conductors, whereby the resistance to alternating currents becomes larger than that due to ohmic resistance only, the lecturer closed the series of lectures with a few general remarks.

A hearty vote of thanks, proposed by the Chairman (Sir H. Trueman Wood), was then given to Dr. Fleming.

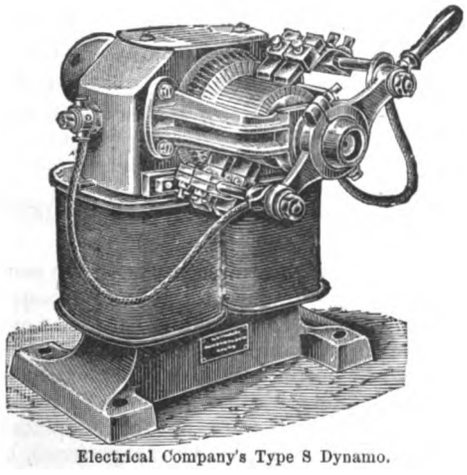
THE ELECTRICAL COMPANY, LIMITED.

The price-list of dynamos and motors issued for 1896 by the Electrical Company, Limited, of 122, Charing Cross-road, W.C., consists of about 55 large square pages, giving in tabular form such information as to the machines manu-



Electrical Company's Automatic Regulator.

factured by the company that when the requirements and conditions are given it is a simple matter to find the machine to fit them. The dynamos and motors are classed by types quoted by letters, and an illustration of each type heads the page. The machines of the same type



Electrical Company's Type S Dynamo.

are then arranged vertically, according to their E.M.F., while the successive columns, read horizontally, give the current, speed, consumption, weight, price, and other details as to accessories required. The list is most methodical in its arrangement, the book presenting the appearance of a succession of tables; and it is noteworthy that the weights and dimensions throughout are given in the metric system. Nearly half the book is concerned with continuous-current machines, this section closing with two pages devoted to directly-coupled engines and dynamos. Small motors for drills, sewing machines, fans, etc., follow, and are succeeded by regulators, resistances, couplings, etc., alternating-current, three-phase, and single-phase motors coming at the end of the list. We reproduce above the illustrations of the company's type "S" dynamo and their automatic regulator.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

February 14, 8 p.m.—Students' meeting. "The Construction of the Molong to Forbes Railway, New South Wales," by Sidney Thow, Stud.Inst.C.E.

February 18, 8 p.m.—Ordinary meeting. Paper to be further discussed. "The Manufacture of Aluminium by Electrolysis, and the Plant at Niagara for its Extraction," by A. E. Hunt, M.I.C.E.

Institution of Electrical Engineers.

February 21, 8 p.m.—At 28, Victoria-street. Students' meeting. "Some Central-Station Experience," by W. Fennell (student)

Royal Institution of Great Britain.

February 21, 9 p.m.—At Albemarle-street, Piccadilly. "The Past, Present, and Future Water Supply of London," by Edwd. Frankland, D.C.L., LL.D., F.R.S., M.R.I.

Society of Arts.

February 17, 8 p.m.—At John-street, Adelphi. "The Chemistry of Metals and Alloys Employed for Building and Decorative Purposes," by Prof. J. M. Thomson, F.R.S.E. (first of three lectures).

February 18, 8 p m.—Foreign and Colonial Section. "The Development of Electrical Traction Apparatus," by H. F. Parshall (General Electric Company, U.S.A).

Royal Meteorological Society.

February 19, 7.30 p.m.—At 25, Great George-street, Westminster. "Report on the Phenological Observations for 1895," by E. Mawley, F.R.H.S., president; "Notes on the Recent Unusually High Barometer Readings in the British Isles," by Robert H. Scott, M A., F R S.; "Turner's Representations of Lightning," by R. Inwards, F.R.Met.Soc., F.R.A.S.

Physical Society.

February 14.—Annual general meeting. "The Determination of High Temperatures with the Meldometer," by W. Ramsey and N. Eumorfopoulos.

City and Guilds Technical College.

February 20.—At the College, Leonard-street, Finsbury. Conversazione, concert, and dance. Lecture on "Invisible Light," by Prof. Silvanus P. Thompson. Exhibition of models, etc.

Engineering Society.

February 14, 4 p.m.—At King's College, Strand, W.C. "The Time-Rate of Growth of Magnetism of Iron and its Importance to the Electrical Engineer" (with experiments), by E. Wilson, M.I.E.E.

Institution of Junior Engineers.

February 14, 8 p.m.—"The Stability of Tall Chimneys," by F. J. Bancroft, B.Sc. (member).

North-East Coast Institution of Engineers and Shipbuilders.

February 14, 7.30 p.m.—At Lecture Hall of Literary and Philosophical Society, Newcastle-upon-Tyne. Ordinary meeting. "Some Structural Details of Modern Ships," by M. C. James.

Liverpool Engineering Society.

February 19, 8 p.m.—At the Royal Institution, Colquitt-street. Eighth ordinary meeting. "Light Railways: Conditions Affecting their Construction and Working," by Alexander Ross, M.I.C.E.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 13.

DR. HOPKINSON (President) in the chair.

At last night's meeting of the Institution the following candidates were elected:

Associates.—Charles Henry Biggs, Glebe Lodge, Champion Hill, S.E.; Alfred W. Fell, 7, Elborow-street, Rugby; Frederick Richard Flew, 5, Glazbury-road, West Kensington, W.; Albert E. Mohring, 59, St. George-street, E.; William Edward Moulsdale, superintendent engineer, Ocean S.S. Co., Singapore; Gilbert C. Vyle, National Telephone Co, Nottingham.

Students.—F. R. Bridger, 26, Priory-road, West Hampstead, N.W.; William Bunn, 8, Albert-road, Stroud Green, London, N.; Eric Mortimer, Technical College, Finsbury; Claud Edward Vance, "Warden," Esmond-road, Bedford Park, W.

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THE

ELECTRICAL ENGINEER.

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TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140, Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

"SITUATIONS VACANT" and "WANT PLACES" Advertisements will be charged at THREE WORDS for ONE PENNY with a MINIMUM charge of SIXPENCE.

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BOUND VOLUMES.

Vol. XV. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

A PROTEST.

We have this week inserted two letters from Messrs. Walker and New with a view, among other things, to utter an emphatic protest against the tendency of modern *fin-de-siecle* men to write such letters. Take Mr. Walker's letter first, as it may be deemed the more important, for therein is claimed that the author long since propounded a theory which the discoveries of recent months are said to support. Now, any man is perfectly justified in getting his theories made public, and in pointing out anything that seems to him to support those theories. Had Mr. Walker stopped there we had nothing to say, but we must and do protest against his view that the technical Press is dominated by the opinions of professors. If Mr. Walker's views commended themselves to the various persons responsible for the different papers, they would be pleased to give those views publicity whatever the opinions of professors. Writers seem to imagine that technical papers are at their beck and call, and under no circumstances ought a letter or article to be rejected. But there is more than one person to be considered in the matter, and we are quite sure that the various editors against whom complaint is made can advance reasons for their action. The modern style of suggesting personal bias in matters journalistic is, in our ideas, a mistake, and to be avoided. "You're another" is not argument—and this brings us to Mr. New's letter. The good taste of our contemporary in giving parallel extracts may be questioned, but a little license may be allowed under the circumstances that existed. Is life worth living, however, if every man is to be pinned down to his views of ten, fifteen, or twenty years back? With fuller information opinions must change, and the man is not worth his salt if he is afraid to say, "I thought so then, but I do not think so now." We wish writers and readers would credit others besides themselves with the desire to do right, and hanker less about "personalities" than about information. There seems to be a greater delight in getting a rise out of somebody than in obtaining information. So long as the laugh is not against themselves people seem to delight in the personalities, hence the success of the so-called society papers. If that style of thinking is to dominate business men, the sooner the end comes the better. The nobler view is to believe other people in earnest as well as ourselves, and to prefer to see the good that exists, rather than to revel in the bad.

THE UNIVERSAL ELECTRICAL DIRECTORY.

The publishers of this directory must be congratulated upon the great improvements they have introduced. Every effort seems to have been made to secure ease of reference, and the number of names inserted has largely increased. A directory to be useful must be fairly accurate. Perfect accuracy is impossible, because from week to week movements are made which were not contemplated when a particular address was given. Our experience, however, is that this directory is carefully corrected, and may be relied upon for accuracy of address and description. It gives the names and addresses of those engaged in the industry in Great Britain, India, the Colonies, America, the Continent,

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etc.—in fact, agreeing with its title "Universal," and must undoubtedly become a necessary work of reference in every house of business so far as the electrical industry is concerned, and we should say will be indispensable in many other cognate branches of industry.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRICITY A MODE OF MOTION.

SIR,—I am very pleased that my attempts to solve the problem in which we are all so deeply interested are at last awakening the interest of thinking men, more particularly as there would appear to be a determined attempt on the part of the editors of certain papers calling themselves scientific to "burke" discussion on this subject, unless the writer who attempts to discuss happens to be teaching physics in a college, and obscures his subject more or less with a lot of useless mathematics. It appears to me to be a singularly foolish attempt to turn the dial of progress backward. Fancy, in an age when everyone who thinks at all is doing all he can to help education forward, and to teach men, above all things, to think, the editors of papers that are supposed to represent advanced scientific thought attempting to stifle thought on the part of those to whom thought—deep and earnest thought, is a necessity of the existence of the work they are engaged on.

May I also mention, before replying to Mr. Avery's able and pertinent questions, that I trust he and others will understand that the theory I have ventured to propound did not spring from my brain full grown, like Minerva from the head of Jove. Readers of your paper will have noticed, if they have read my contributions to your columns for some years past, that the views I now hold were formed very gradually, and that even after I ventured to launch the theory very much remained to be done in the matter of developing it in all its bearings. Very much, even now, still remains to be developed, and it is for this reason I so gladly welcome intelligent criticism such as that contained in Mr. Avery's letter. May I add that I venture to hope for his co-operation, and that of other readers who are interested in the matter, in putting the theory if, as I hope and believe it is scientifically correct, upon a firmly established basis.

And now to reply to Mr. Avery's queries. First, why should electricity and electromagnetism be placed so far apart? Perhaps I had better explain that I look upon magnetism and electromagnetism as two entirely different forms of motion. It is electromagnetism that I place beyond the ultra-violet rays, because it appears to me there is no other place for it, unless its place be somewhere within the region of the spectrum, but with a motion of a different character to that of the heat and light rays. It cannot come between electricity and heat because, as we know, the smallest resistance placed in the path of the electric wave instantly results in conversion of a portion of its energy into heat waves.

It may have a particular form of motion of its own within the range of the spectrum, but we have no evidence pointing that way, and, on the other hand, we have evidence pointing distinctly to a very high rate of motion—viz., the great resistance offered to the wave-motion—by the insulating envelope of the conductor, and the necessarily very great increase in the rate of the wave-motion and decrease in the wave-length.

Next, as to the solenoid. My remark above will have cleared the ground in this matter. I look upon magnetism as energy, molecular and ethereal motion, stored in the molecules of the iron at their creation. The motions are more or less masked by the conditions under which the iron molecules exist, and their presence is not always apparent. In pure iron, however, we have these motions, as I understand them, in full vigour; but when in what we call the non-magnetic state they are again masked by the closed figures formed by the molecules themselves, the motions passing round and round each group.

When we magnetise an iron bar, as we express it, in my view, we set free these motions and make them visible outside the bar, just as we may render visible the energy stored in a suspended body by removing its support. Hence it follows that it is not necessary for the waves to pass through the states we know as heat and light. What particular form of motion magnetism is, and where it should be placed, requires further study. That the direction of propagation of its motion is not the same as the direction of the electromagnetic wave, a little consideration will, I think, make apparent.

Further, it appears to me that a careful study of the attractions exhibited by magnets and electromagnets, using the terms in the ordinary manner common at present, and of electrostatically-charged bodies, should lead us on towards the solution of that more important question, What is gravitation? Next, as to the changes of the wave-lengths from electric waves to invisible heat, then red and on to violet and ultra-violet. Mr. Avery asks if we go on increasing the current, should we not obtain pure magnetism? I will substitute for this pure electromagnetism, following on the view I have expressed above as to what I conceive magnetism to be. My view on this matter is that undoubtedly you will obtain electromagnetism, but probably not alone; and this is what I make out that Prof. Röntgen has obtained. You have to remember that if you go on increasing the electric current passing in a metal conductor to this extent, you will alter the physical state of the conductor long before you have arrived at the rate of vibration at which I conceive that electromagnetism begins.

If you can imitate the conditions that you would have, if you could go on increasing the rate of vibrations without altering the physical condition of the conductor, you do obtain electromagnetic waves—viz., in the media surrounding an insulated conductor in which an electric current is passing; and, also, as I think, in Prof. Röntjen's experiments.

Next, as to why the waves, which I conceive an electric current to consist of, take the path of the conductor instead of the majority of them diverging into space? I should like to join with this question an objection that was made to me by an eminent practical electrical engineer a short time since. "I agree with you in part," said this gentleman, "but I do not see how you get over the difficulty that different waves corresponding to different physical forces occur in different media."

The answer to both questions is, I think, the same. It appears to me that the motions, wave-motions principally, of which the physical forces consist, take place both among the molecules of the body in which the particular force is manifest and in the ether as well. Naturally, what may be called the coarser motions, the long, slow waves, are more apparent in the molecules of the body itself, because they have the power to move those molecules. As the rates of motion increase, and the wave-lengths and the amplitude of the vibrations decrease, the waves have less and less power over the molecules themselves and become more and more confined entirely to the ether. Sound waves, for instance, being the longest, are almost wholly confined to the molecules of the bodies through which they pass. Heat waves pass largely by means of the ether, but they must undoubtedly also move the molecules of heated bodies, as all bodies take up a larger space under the influence of heat. Light waves, that is to say, the shorter waves of the spectrum, pass more by way of the ether, though they, too, are present also among the molecules of luminous bodies. I am not quite clear as to Mr. Avery's last question. As I understand the matter, as the rate of vibration increases as you confine the motion, whether among the molecules of the body or in the ether, the wave-length decreases and the rate of transmission of the wave increases and *vice versâ*. I trust that Mr. Avery will return to the charge, and that others will also join in the discussion.—Yours, etc.,

SYDNEY F. WALKER.

Cardiff Electrical Works, Severn-road, Cardiff.

USEFUL ELECTRIC LAMPS.

SIR,—There is something pathetic in the manner in which the English cling to the delusion of the supremacy of British manufactures. A much wiser commercial policy is to own up manfully when we are beaten by our foreign

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competitors; by so much the sooner will the country realise its deficiences and thus regain its rapidly declining position in the world's market.

I am led to pursue this somewhat hackneyed reflection by the perusal of a letter from Mr. Frederick Walker in your last issue, wherein he states that English-made lamps are superior in every point of efficiency to any imported from abroad. Much as I should like to support his statement on patriotic grounds, I regret I am unable to do so.

English makers have not yet succeeded in turning out a successfully commercial and economical 8-c.p. lamp even at 115 volts.

Referring now more particularly to lamps of higher voltage, if English makers would cease "sounding notes of warning" and sound the depths of their inventive faculties instead, they might be more profitably employed both for themselves and their countrymen.

While certain energetic and farseeing manufacturers are busily engaged perfecting their lamps and hedging them round with valuable patents, the English manufacturer goes on sounding his note of warning and assuring the public that a reliable high-voltage lamp cannot be made.

It is obvious that defective German or foreign lamps are to be met with. We find good and bad English lamps even amongst those of ordinary voltage, but there is no shadow of doubt that up to the present certain foreign-made high-voltage lamps are infinitely superior to anything of the kind made in England.—Yours, etc.,

February 12, 1896. SYDNEY W. BAYNES.

COMPARISON.

SIR,—The following extracts may be of some interest or amusement to your numerous readers.

The *Electrical Review* of January 31, 1896, gives us the following with regard to the Hall *v.* Alabaster and Co. case:

MR. LAWSON WALTON, Q.C., FOR AND AGAINST.

Mr. Lawson Walton appeared for us against Dr. Tibbitts in February, 1893, and made us blush by saying:	Mr. Lawson Walton appeared against us in the Hall case, and said:
"Mr. Alabaster and Mr. Gatehouse and Mr. Kempe founded the *Electrical Review*. . . . They were all scientific men, who were specially responsible for the article which was impugned, were men of some eminence in a profession which involved a knowledge of electricity. They . . . were men who could form an opinion of some weight."	"The defendants were a trade journal, and their news columns were largely devoted to describing the machines and operations which they advertised."

Compare with:

Mr. Frank King in his evidence in the above mentioned trial stated:	Mr. Frank King in his patent specification No. 1,731 of 1895 (in combination with Mr. Faure) claims the following:
"He had had a very large and distressing experience in the use of celluloid in the cells. He had used a great number of tons of it. Celluloid had been discarded as giving an additional mechanical strength to those plates."	"In or for secondary batteries the use of a sheet of silicated asbestos fabric, such as is hereinbefore described in combination with perforated celluloid, ebonite, or other sufficiently acid-resisting material for retaining the active material in place as above set forth."

I wonder which discrepancy is the more unwarrantable, and whether imitation is still the sincerest form of flattery? Yours, etc., ANTHONY G. NEW.

10, Bridge-street, Westminster, S.W., February 12, 1896.

SOUND CASTINGS FOR ELECTRICAL WORK.

SIR,—In reply to the question of "Reader" in your issue of February 7, I am not surprised that he failed to obtain ferro-sodium of Glasgow chemists, or, for that matter, ferro-manganese, ferro-silicon, or other iron alloys used in iron or steel working. Chemists do not supply such things, they not being in general demand. The only makers of ferro-sodium in this or any other country is the Ferro-Sodium Company, Limited, whose Scottish agents are the Ironfounders' Grinding Company, of 3, West Scotland-street, Glasgow. As to what ferro-sodium is, it may be well to say that it is an alloy of iron and sodium, both chemically and mechanically combined, and that, used as directed, it causes the production of absolutely sound castings.—Yours, etc., WALTER J. MAY.

February 8, 1896.

THE TELEPHONE QUESTION.*

BY ALFRED R. BENNETT, M.I.E.E.

The interest which the telephone question is exciting in Scotland and the country generally at the present time must be my excuse for troubling the members of the East of Scotland Engineering Association with a paper partaking more of an economical than of a technical character. British engineers and manufacturers have at present, owing to the backward and exclusive position of the industry, but few opportunities for contributing to the advancement of telephony, and their first solicitude should be the creation of a field in which their talents may be exercised; then technical considerations may with more propriety receive attention. Several important facts connected with the telephone question have recently been presented in a manner which advocates of the existing state of matters in the United Kingdom have not seen their way to challenge.

These facts may be briefly summarised as follows:

(1) That in the great majority of foreign countries the rates of subscription paid by telephone subscribers are notably lower than those exacted in the United Kingdom. In some countries the difference is scarcely credible, as the subscription, including erection and maintenance of all necessary wires and instruments, descends as low as £2. 14s. 4d., £2. 9s. 6d., and even £1. 13s. 4d. per annum.

(2) That in many foreign countries the telephonic development greatly exceeds that which has been attained in the United Kingdom. This development in many places has reached such a stage that there is one telephone to every 30 inhabitants, including women and children, while in a few localities the proportion is as high as one telephone in 20 and one telephone in 18. When it is stated that in the United Kingdom the proportion, according to the latest published figures, is 1 in 636, the amount of lost ground which we have to make up will be appreciated.

(3) That the difference in the charges between Continental countries and the United Kingdom is not caused by cheapness of labour, or cheapness of materials abroad, as it has been proved that, as a rule, foreign companies and administrations pay their servants at least as well as we do ours, and not infrequently better, and that their apparatus costs them more.

(4) That the greatest degrees of development are attained by means of local enterprise, those countries which allow local companies to do the telephonic work standing at the head of the list, not only as regards the number of telephones to population, but as regards cheapness of subscription and general efficiency.

(5) That the telephone is put to more numerous uses abroad than it is in the United Kingdom, so that although the foreign telephone subscriber pays less for his connection, he gets a variety of uses out of it which are unknown here.

(6) That municipal enterprise has been successfully applied to the management of telephone exchanges, so that one of the best worked exchanges, and at the same time one of the cheapest, is owned and worked by a town council.

(7) That competition between two telephone companies within the same area has a stimulating effect on the growth of telephonic work, while it is not inimical to good service. Competition does not exist in many countries, but wherever it shows itself its effects are at once apparent by the low rates which prevail and the high stage of development attained.

It would be superfluous to repeat here proofs which have been given of the truth of the foregoing statements, as each and all of them have been severally examined and discussed publicly during the last six months. I shall, therefore, ask you to accept them as true. The question then arises, why cannot the circumstances which have led to such good results abroad be repeated at home?

The answer is furnished (1) by the existence in the hands of one company of a complete monopoly of the telephone exchange business in the United Kingdom, with the exception of a few insignificant exchanges owned by the Post Office; (2) by the policy of the Post Office, which is to support the monopoly possessed by that company.

While advocating in the House of Commons the conclusion of the agreement between the Post Office and the National Telephone Company, by which, in return for several valuable concessions, the company consented to sell its trunk lines to the Post Office, the two last Postmasters-General, Sir James Fergusson and Mr. Arnold Morley, deprecated the idea of investing any company with a monopoly, and, when the danger of such a situation being created was urged, pointed to the

* Paper read before the East of Scotland Engineering Association at Edinburgh, February 5, 1896.

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clause in the proposed agreement which reserved the right of the Post Office to grant new competing licenses if necessary, so that the public would always possess a remedy against bad service or high rates; and on these assurances the agreement was allowed to be passed, although many members of Parliament expected, from the wording of the report of the Select Committee, which had recommended the agreement, that an opportunity would be afforded them of inspecting it in its final form before signature, which expectation, however, proved illusive, as the late Government refused to permit anything of the kind being done.

Relying on this clause in the agreement, and on the reiterated statement in the House that the Post Office had reserved the right to grant additional licenses, the Corporation of Glasgow, in which town the service given by the National Telephone Company had come to be regarded as unsatisfactory, applied for a license to erect and work a telephone exchange of its own. Without opposing a direct negative to the application, the Postmaster-General refused it in effect by prevaricating about his promise to grant additional licenses, and by seeking to give that undertaking a different interpretation to the meaning which it bore in plain English, and to the meaning which had without suspicion been assigned to it by those members of Parliament who were anxious for telephonic reform.

(To be continued.)

ABERDEEN ELECTRIC LIGHTING ACCOUNTS.

The accounts of the past year's working of the Aberdeen Corporation electric light station have just been issued. The loans sanctioned under the provisional order amount to £32,000, of which £29,800 has been borrowed.

Dr. CAPITAL ACCOUNT.

	£	s.	d.
Loans on mortgage	19,800	0	0
Temporary loan	10,000	0	0
	£29,800	0	0

Cr.	Expenditure less depreciation at Dec. 31, 1894. £ s. d.	Depreciation to Dec. 31, 1895. £ s. d.	Add expenditure for year to Dec. 31, 1895. £ s. d.	Balance of expenditure at Dec. 31, 1895. £ s. d.
Buildings ...	4 470 6 5	44 19 8	75 19 9	4,501 6 6
Machinery ...	6,256 4 1	321 14 10	3,796 10 5	9,730 19 8
Accumulators	765 7 8	39 9 2	107 17 4	833 15 10
Mains and services ...	9,670 0 8	146 11 5	2,216 13 8	11,740 2 11
Electrical instruments..	1,126 18 11	28 15 5	229 7 1	1,327 10 7
Meters	900 9 9	45 12 9	554 6 10	1,409 3 10
	23 189 7 6	627 3 3	6,980 15 1	29,542 19 4
Balance of capital account				257 0 8
				£29,800 0 0

REVENUE AND EXPENDITURE ACCOUNT.

Dr.	£	s	d.
Sale of current, per meter	3,298	1	2
Public lighting	156	8	1
Rental of meters	156	19	6
	£3,611	8	9

Cr.	£	s.	d.
Fuel	193	6	5
Oil, waste, water, and engine-room stores	51	9	2
Wages at generating station	265	0	8
Repairs on buildings	21	1	7
Repairs on plant	191	18	7
Main and service repairs	26	0	7
Meter repairs	0	12	0
Rent and feu-duty	16	18	6
Taxes	190	18	9
Management	70	0	0
Salaries	204	19	11
General establishment charges	46	4	6
Stationery and printing	59	18	11
Insurance	13	1	0
Inspector's wages	2	7	6
Bad debts	2	19	11
	1 356	18	0
Balance carried to net revenue account	2,254	10	9
	£3,611	8	9

NET REVENUE ACCOUNT.

Dr.	£	s.	d.
Balance brought from revenue and expenditure account	2,254	10	9
	£2,254	10	9
Balance brought down	£435	0	9
Amount received from gas department, being loss to December 31, 1894	217	15	6
	£651	16	3

Cr.	£	s.	d.
Interest on mortgage and other loans	713	15	6
Depreciation: Buildings, at 1 per cent., £44. 19s. 8d.; machinery, at 5 per cent., £321. 14s. 10d.; accumulators, at 5 per cent., £39. 9s. 2d.; mains and services, at 1½ per cent., £146. 11s. 5d.; electrical instruments, at 2½ per cent., £28. 15s. 5d.; meters, at 5 per cent., £45. 12s. 9d.	627	3	3
Sinking fund on £23,557. 15s. at 2 per cent. — 471 3 1			
Interest on sinking fund, at 2½ per cent. — 7 8 2			
	478	11	3
Balance, being profit for the year	435	0	9
	£2 254	10	9
Balance at debit, December 31, 1894	£217	15	6
Balance carried to general balance account	435	0	9
	£652	16	3

GENERAL BALANCE ACCOUNT.

Dr. Assets.	£	s.	d.
Capital account — works, as per account No. II. £30,538 10 1			
Less depreciation written off.. ... 995 10 9			
	29,542	19	4
Sundry debtors for current supplied to December 31, 1895, outstanding 1,881 12 2			
Ditto for service lines 154 0 0			
	2,035	12	2
Stores on hand at July 31, 1895: Coal, £4. 1s. 6d.; oils, waste, etc., £9. 5s. 6d.; engine spares, cable, etc., £1,006. 19s. 5d	1,020	6	5
	£32,598	17	11

Cr. Liabilities.	£	s.	d.
Capital account— Amount of mortgage loans	19,800	0	0
Amount of temporary loans	10,000	0	0
Net revenue account—amount at credit thereof	435	0	9
North of Scotland Bank	801	10	7
Amount due to sundry creditors	782	2	0
Amount of deposit in security for current	5	0	0
Sinking fund	775	4	7
	£32,598	17	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		159,777
Quantity sold:		
Public lamps ...	8,257	138,372
Private consumers, by meter	130,115	
Quantity used in works		1.769
Total quantity accounted for		140 141
Quantity not accounted for		19,636
Number of public lamps		10

COMPANIES' MEETINGS AND REPORTS.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The ordinary half-yearly general meeting of this Company was held last Friday at Winchester House, E.C., the Marquis of Tweeddale presiding.

The **Chairman**, in moving the adoption of the report, said that it was the best that had been presented to the shareholders since 1892. In the half-year ending 1892 there was paid a dividend of £1. 10s. per cent.; in 1893 it fell to £1. 6s.; in 1894 to £1. 3s; but this half-year the Board were able to recommend a dividend for the half year at the rate of £1. 8s., of which 10s. had already been paid, leaving a balance of 18s. The increased dividend was due, first, to improved traffics; secondly, to an increase in the receipts from the steamship "Minia"; and, thirdly, to a considerable reduction in their expenses. The increase in traffic amounted to £15,764, due, of course, to the great improvement which had taken place in commerce and business. The "Minia" had earned £1 350 more than last year, and the decrease of expenses amounted to £1,056. That decrease in expenditure was all the more satisfactory, inasmuch as it compared with the half year when the decrease amounted to no less than £3 399. Since 1891 the expenses showed a total decrease of £8,712. The renewal fund now stood at £624,265, and the value of the securities held by the Company had increased by no less than £74,000. Owing to the lease of their offices in Threadneedle-street coming to a termination, the Board had purchased for £28,541 the lease for 13 years of very suitable premises in Old Broad-street. The new offices were superior to the old ones, and by letting off a certain portion of the building the cost to them would be practically the same as they had previously paid. Their cables were in a very satisfactory condition. It was true that during the half-year they had not been altogether free from interruptions, but, with the exception of the 1873 cable, which was interrupted in the preceding half-year and repaired on July 16, the interruptions had been confined to their short cables west of Newfoundland and to their cable in the shallow sea. The repairs had been executed with that skill and promptitude always exhibited by their officials, both in the ship "Minia," commanded by Captain Trott, and by their local officials at St. Pierre, who, in face of great difficulties from

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the weather and other causes, repaired one of their most important short cables with perfect success. He was sorry to say that the French case was very little nearer a settlement than it was when he last met them. He need hardly say that it was not from any want of energy on the part of the Company, but the French lawyers, being not unlike our own, were not disposed to be in too great a hurry in the settlement of such matters. He was glad to say that the new half-year had commenced in a manner which augured very well for the current six months. The Chairman concluded by moving: "That the report of the directors and accompanying statement of accounts to December 31, 1895, submitted to this meeting be, and the same are hereby received and adopted, and that the following dividends as recommended by the Board be now declared and paid, less income tax—that is to say: (1) a final dividend of 18s. per cent. upon the ordinary consolidated stock for the year ending December 31, 1895 (making, with £1. 11s. per cent. interim dividends already declared and paid by the Board by way of dividends on account) a total dividend for the said year of £2. 9s. per cent on the said stock; (2) a final dividend of £1. 16s. per cent. upon the preferred ordinary stock for the year ending December 31, 1895, making, with £3. 2s. per cent interim dividends already declared and paid by the Board by way of dividends on account, a total dividend for the said year of £4. 18s. per cent. on the said stock."

Mr. F. A Bevan seconded the resolution.

Mr. Garner asked for some information as to the probable limit of the renewal fund. Cables could be repaired much easier to-day than formerly.

Mr. Wood said that steps ought to be taken, if possible, to expedite the French case, and **Mr. Davis** thought the shareholders ought to be told more fully how the case stood. If they did not expect to receive much, the matter ought to be concluded.

Mr. Griffith said it was preposterous that half-year after half-year the case should still be pending. They could not suppose that the judges of the highest courts in France were deliberately doing something to keep the case back.

In reply, the **Chairman** said the Company's legal advisers here and in France were doing all they could, but they could not force the case before the Court of Appeal any quicker than the authorities were willing to take it. There was no delay on the part of the Company. He must say distinctly that the Board did not expect to get any substantial sum as the result of the settlement of the case. In his opinion, the French Cable Company would not be able to pay any very heavy damages if they were awarded. As to the renewal fund, he was unable to say definitely what amount it should reach before being considered large enough. Their cables were growing older every day, and when they were newer it was thought that £1,000 000 would be barely sufficient to make them feel quite confident of being able to keep their four cables in good working order.

Mr. C Burt was afraid the discussion that had taken place on the case might have a prejudicial effect so far as they were concerned. Having gone so far, and paid almost every item of costs they had to pay up to the present time, they would surely go on with the case and obtain a final decision after striving for so many years to get justice done to them.

The resolution was subsequently agreed to unanimously.

WATERLOO AND CITY RAILWAY COMPANY.

The half-yearly general meeting of the Waterloo and City Railway Company was held last week in the Board-room at Waterloo Terminus.

The **Chairman**, in moving the adoption of the report, said that the total amount of share capital received was £216,000, of which they had expended £122,736. The capital expenditure during the period under review amounted to £62,321, and it was estimated that during the next six months £105,000 would be expended. To provide for a part of this money it was probable that a further call would have to be made.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Alfred Sohier Bolton, Esq.; Sir. Frederick J. Bramwell, Bart., F.R.S.; G H. Hopkinson, Esq; Granville R. Ryder, Esq; R. W. Wallace, Esq., Q C.

Directors' report to be presented at the ninth ordinary general meeting to be held at 1, Great George-street, Westminster, on Thursday, February 20, 1896, at 5 p.m.:

The directors submit to the shareholders a statement of the accounts of the Company, together with a report of the position of the undertaking at the end of the year 1895. The mains, which extended to a length of 18¾ miles on December 31, 1894, have been increased during the year 1895 to 20 miles During the year the number of houses and shops connected with the system has increased from 908 on December 31, 1894 to 1,109 on December 31, 1895; while the number of lamps calculated on the usual basis of 8 c.p. has increased from 80,678 to 94,780. The debenture debt of the Company has been converted from 4½ per cent. first mortgage debentures to 4 per cent. debenture stock. The debentures were paid off at £105 by new stock issued to the holders. Further issues of debenture stock have since been made, £6,800 at £103 and £15,755 at £105 per cent., of which amount £11,780. 15s. was paid by December 31. The directors have thought it advisable to appropriate the balance of premiums thus obtained, after deducting the expenses of creation and issue of this stock, to the reduction of the cost of conversion. The directors have written £1,000 off the goodwill account, and strengthened the renewal account by transferring to it £4,270. 2s. 11d., making the total amount placed to that account £9,990. 13s. 8d. After providing for the above amounts and paying the dividends on the 6 per cent. first preference shares to June 30, 1895, on the 5 per cent. second preference shares to September 30, 1895, and an interim dividend at the rate of 5 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1895 is £5,227. 7s. 6d. Of the above sum £1,450 has been appropriated to the payment of the first preference dividend to the end of the year, and £150 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date, leaving £3,627. 7s. 6d., out of which it is proposed to pay a further dividend on the ordinary shares at the rate of 7 per cent per annum for the past half-year, making, with the interim dividend paid to June 30, 6 per cent. for the year. This will leave a balance of £1,089 17s 6d. No provision has been made in the accounts for directors' remuneration. In accordance with the articles of association, Mr. Granville R. Ryder and Mr. Alfred Sohier Bolton retire from the directorship, and, being eligible, offer themselves for re-election. The auditors, Messrs Lovelock, H. W. S. Whiffin, and Dickinson, offer themselves for re-election.

Balance-Sheet to Dec. 31, 1895.

Dr.	£	s.	d.
Capital—15,000 ordinary shares of £5 each	75,000	0	0
10,000 6 per cent. first preference shares of £5 each	50,000	0	0
2,500 5 per cent. second preference shares of £5 each	12,500	0	0
4 per cent. debenture stock	71,080	15	0
Sundry creditors and open accounts	7,408	18	3
Renewal account, balance at credit thereof	9,990	13	8
Net revenue account	5,227	7	6
	£231,207	14	5

Cr.	£	s.	d.	£	s.	d.
Plant, buildings, mains, furniture and fittings, provisional orders, goodwill, and South Kensington order, at cost	192,692	15	11			
Less amount written off goodwill	1,000	0	0			
				191,692	15	11
Freehold and leasehold property	15,059	7	5			
Less sinking fund	809	8	3			
				14,249	19	2
Sundry debtors				10,393	6	8
Stock-in-trade and stores				511	11	4
Consols				549	3	10
Cash at bankers	11,871	2	4			
Cash in hand	15	19	8			
				11,887	2	0
Conversion of £50,000 4½ per cent. debenture bonds at 5 per cent. premium into debenture stock, together with expenses connected therewith	2,679	0	6			
Less premiums received	755	5	0			
				1,929	15	6
				£231,207	14	5

Revenue Account, Year ending Dec. 31, 1895.

Dr.	£	s.	d.
Manufacturing electricity, coal, oil, water, waste, sundries	6,068	10	7
Salaries	1,946	12	2
Miscellaneous expenses, including law charges	647	18	8
Rent, rates, and taxes	1,393	6	11
Insurance	236	0	0
Sinking fund, leasehold	253	0	0
Maintenance of buildings, mains, plant, meters, instruments, etc.	2,208	10	11
Repairs to leasehold property	192	6	3
Company's auditor	52	10	0
Board of Trade auditor	37	0	0
	13,035	15	6
Renewal account in respect of buildings, mains, plant, batteries, meters, and furniture	4,270	2	11
Amount written off goodwill account	1,000	0	0
Cost of making good damage by fire not covered by insurance	48	1	7
	5,318	4	6
Balance	10 988	0	2
	£29 342	0	2

Cr.	£	s.	d.
Sale of electricity (1,228,734 units)	30,592	3	11
Less rebates and bad debts	2 501	10	8
	28,090	13	3
Rent of meters	920	1	0
Sale and maintenance of lamps	10	16	3
Rent receivable	299	19	10
Transfer fees	5	5	0
Apparatus sale and maintenance	15	4	10
	£29,342	0	2

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Dr. NET REVENUE ACCOUNT.		£ s. d.
Interest on sinking fund		21 8 0
Dividends on 5 per cent. second preference shares to Sept. 30, 1895	£592 12 5	
Dividends on 6 per cent. first preference shares to June 30, 1895	1,450 0 0	
Interim dividend at 5 per cent. per annum on ordinary shares to June 30, 1895	1,812 10 0	
Interest on debentures accrued to date, less income tax	2,370 10 3	
		6,225 12 8
Balance		5,227 7 6
		£11,474 8 2
Cr.	£ s. d.	£ s. d.
Balance from last account	4,235 14 10	
Less dividends to December 31, 1894—6 per cent. first preference shares, £1,450 ; ordinary shares, £1,812 10s.; directors' fees, £500	3,762 10 0	
		473 4 10
Interest		13 3 2
Balance from revenue account		10,988 0 2
		£11,474 8 2

Dr. RENEWAL ACCOUNT.	£ s. d
Balance	9,990 13 8
	£9,990 13 8
Cr.	£ s. d.
Balance from last account	5,720 10 9
Amount brought from revenue account	4,270 2 11
	£9,990 13 8

CASTNER-KELLNER ALKALI COMPANY, LIMITED.

The statutory meeting of this Company was held last week at the Cannon-street Hotel, E.C., Mr. W Mather presiding.

There was no business to be transacted, but the **Chairman** stated that the directors had secured a very eligible site for the erection of the works at Weston Point, on the estuary of the Mersey. The building of the works had commenced, and would be pursued with the utmost diligence. The Company did not stand alone in beginning the electrolytic process in connection with a large chemical industry. One of their largest shareholders was the Deutsche Solvay Werke Gesellschaft, the directors of it having been so far satisfied with the investigations they had made in the Castner-Kellner electrolytic processes that they had not only subscribed largely to the capital of the Company, but had determined to erect works in Germany simultaneously with the works now being erected in England. The Board had thought it desirable at present to confine themselves to one-fourth of the plant ultimately contemplated, and to get such advantage as time and experience would give them before proceeding with the remainder.

LIVERPOOL OVERHEAD RAILWAY.

The half-yearly general meeting was held on Tuesday at Liverpool, Sir William Forwood presiding.

The **Chairman**, in moving the adoption of the report, congratulated the shareholders on the increasing prosperity of the Company, the shares of which were now quoted at 13, against 5 formerly. The line was being maintained in the best possible condition, and over 98 per cent. of the trains were run on time, being a record performance, and spoke well for electricity as motive power.

The report was adopted.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

Directors: S. Wm. Silver, Esq. (chairman), Abraham Scott, Esq., Matthew Gray, Esq. (managing director), the Hon. Henry Marsham, A. Weston Jarvis, Esq.

Report of the directors for the year ending December 31, 1895, to be presented at the thirty-second ordinary general meeting of the shareholders, to be held at the Cannon-street Hotel, London, on Thursday, February 20, 1896, at 12 o'clock noon :

The annexed accounts show, after provision for doubtful debts, a net profit for the past year of £49.325. 12s Adding £20,913 17s. 4d. brought forward, and deducting £12,500 interim dividend paid in July there remains a disposable balance of £57,739 9s. 4d. The directors recommend the distribution of a dividend of 15s. a share free of income tax, amounting to £37,500, making, with the interim dividend, a total payment of 10 per cent. for the year, and leaving £20,239. 9s. 4d. to be carried forward. The year's general business has been satisfactory, and the cable department and steamships have been moderately employed. The Silvertown and Persan factories are in good order. Before the next accounts are presented the directors will propose alterations in the Company's articles of association as to the form of balance-sheet and profit and loss account in accordance with the suggestion of the auditor. The Company's 4½ per cent. debentures are repayable next month, and it is intended to issue new debentures at 4 per cent. Particulars of the new issue will be sent to the shareholders. The death of Mr. Robert Henderson in September has deprived the Board of a much-valued colleague. Mr. Silver and Mr. Scott, who retire by rotation, offer themselves for re-election as directors.

BALANCE-SHEET TO DEC 31, 1895.

Dr. Capital and Liabilities.	£ s. d.
Authorised share capital	812,000 0 0
Share capital—amount paid on issue of 50,000 shares of £10 each	500,000 0 0
Mortgage debentures	200 000 0 0
Reserve fund	450 000 0 0
Debts and loans owing by the Company	150,446 19 4
Bills payable	23,932 4 10
Unclaimed dividends	60 15 0
Profit and loss account—balance... £70,239 9 4	
Less interim dividend paid in July 12,500 0 0	57,739 9 4
	£1,382,179 8 6
Cr. Assets and Expenditure.	£ s. d.
Freehold and leasehold premises (Silvertown, Persan, London, and Liverpool), machinery and steamships	488,149 11 3
Debts owing to the Company	275,376 7 3
Cash with bankers in current account, and in hand	18,760 8 11
Stock-in-trade, including 150 miles of cable laid	254,217 3 6
Debentures and shares in other companies	210,589 8 0
Cash, stock, etc., at Persan and agencies, after deducting liabilities	135,056 9 7
	£1 382,179 8 6

PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC 31, 1895.

Dr.	£ s. d.
Salaries, interest, rent, rates and taxes, repairs, and general expenses	62,695 6 3
Bad debts	1 312 15 3
Income tax	3,352 8 8
Depreciation written off buildings and machinery	16.243 18 0
Directors' remuneration	2 000 0 0
Balance—profit for the year, carried down	49,325 12 0
	£134,930 0 2
Cr.	£ s. d.
Gross profit	134 930 0 2
	£134,930 0 2
Balance brought down	£49,325 12 0
Amount brought forward from 1894	20,913 17 4
Carried to balance sheet	£70 239 9 4

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

Directors: The Right Hon. Lord Suffield, K.C.B., Edmund Boulnois, Esq. M P., W. Hayes Fisher, Esq , M.P., Sir Douglas Galton, K.C.B., F R.S., J. Browne Martin, Esq., James Heslop Powell, Esq., R. W. Wallace, Esq., Q.C. General manager: Captain Edmund I. Bax. Engineer-in-chief: Prof. Alex. B. W. Kennedy, LL.D., F.R S., M I.C.E. Secretary: Frank Iago, Esq.

Report of the directors to be presented to the shareholders at the ordinary general meeting to be held at the offices of the Corporation, Eccleston-place, S.W., on Wednesday, February 19, 1896, at 11 o'clock:

The Board of directors, in presenting their report and the accounts for the year 1895, are pleased to state that the business of the Corporation continues to make satisfactory progress. The supply of current, which on December 31, 1894, was provided for the equivalent of 167,703 lamps of 8 c.p., had increased by December 31, 1895, to the equivalent of 210,982 and at the present time there are on circuit the equivalent of 216 822 lamps of 8 c.p., and applications have been received for a further 6,478. The length of roadway in which mains have been laid now exceeds 39 miles, making about 156 miles of ways, into which upwards of 123 miles of copper (strip and cable) have been drawn. The plant and machinery have been working satisfactorily throughout the year, and have been fully maintained from revenue, and a further reduction has been effected in the cost per unit in generating, distributing, and general expenses. In consequence of the increase in the business of the Corporation, the directors have found it necessary to acquire additional property at Eccleston-place and Millbank-street. In dealing with the revenue of the past year, your directors have, after writing off bad debts, a portion of preliminary expenses, and placing £953 to credit of sinking fund, added a sum of £9,780 to the depreciation account. The net revenue of the year amounts to £23,731. 11s. 9d., out of which an interim dividend at the rate of 5 per cent. per annum for the half-year ending June 30, 1895, has been distributed. The Board now recommend the payment of a dividend at the rate of 9 per cent. per annum, less income tax, for the past half-year, making 7 per cent for the year ending December 31 last, carrying forward a balance of £1,338. 14s. 10d. The holders of founders' shares becoming entitled to a share of the surplus profits after payment of a dividend of 7 per cent., this balance will be carried forward as follows: ordinary shareholders' undivided profit account, £1,004. 1s. 2d. ; holders of founders' shares, £334. 13s. 8d. The premium of £8,000 received on the issue of new shares has been carried to the credit of the reserve fund, and invested. In

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accordance with the articles of association, two of the directors, James Heslop Powell, Esq., and J. Browne Martin, Esq., retire, but, being eligible, offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1895.

A.—To Generation of Electricity.

Dr.	£ s d.	£ s. d.
Coal, carriage, unloading, etc	6,774 15 10	
Oil, waste, water, and engine-room stores	1,320 19 6	
Proportion of salaries of engineers and officers	1,755 19 6	
Wages, etc., at generating stations	4,999 11 5	
Repairs and maintenance—buildings, £169. 17s. 1d.; plant, £1,544. 0s 2d.; instruments, £2. 3s. 3d.	1,716 0 6	
		16,567 6 9

B.—To Distribution of Electricity.

Repairs and maintenance of mains—materials, etc., £58. 14s. 5d.; proportion of salaries of officers, £110; wages, etc., £599. 8s. 3d.	768 2 8	
Repairs and maintenance of meters—materials, etc., £257. 12s. 8d.; wages, etc., £265. 19s.	523 11 8	
		1,291 14 4

C.—To Rents, Rates, and Taxes.

Rents	951 12 8	
Rates and taxes	2,179 3 4	
		3,130 16 0

D.—To Management Expenses.

Directors' fees	1,500 0 0	
Salaries of manager, engineer-in-chief, secretary, clerks, etc.	4,046 6 4	
Stationery and printing	292 11 11	
General charges and office expenses	482 15 2	
Auditors of Company	52 10 0	
Wages of meter readers, inspectors, etc.	897 11 11	
Depreciation on office furniture	46 0 0	
		7,317 15 4

E.—To Law and Parliamentary Charges.

General law charges		196 16 4

F.—To Depreciation, etc.

Sinking fund	953 0 0	
Depreciation account	9,780 0 0	
Amount allowed for loss on coal stored	30 5 10	
		10,763 5 10

G.—To Special Charges

Insurance	428 19 9	
Board of Trade audit	68 1 0	
Cost of steam supplied to consumers	784 15 1	
		1,281 15 10
Total expenditure		40,549 10 5
Balance to net revenue account		28,962 19 4
		£69,512 9 9

Cr.	£ s. d.
Sale of current by meter	65,534 8 3
,, ,, contract	20 4 0
	65,554 12 3
Less bad and doubtful debts	108 19 1
	65,445 13 2
Rental of meters, etc., on consumers' premises	3,050 13 8
Transfer fees	49 15 0
Consumers for supply of steam	966 7 11
	£69,512 9 9

Dr. NET REVENUE ACCOUNT.	£ s d.	£ s. d.
Interest on mortgage debentures	4,647 0 0	
Less income tax	154 18 0	
	4,492 2 0	
Interest on sundry accounts	218 15 6	
	4,710 17 6	
Amount written off preliminary expenses account	2,500 0 0	
Balance carried to general balance-sheet	23,731 11 9	
	£30,942 9 3	

Cr.	£ s. d.	£ s. d.
Balance from last account	10,366 8 6	
Less additional fees voted to directors at general meeting	700 0 0	
	9,666 8 6	
Dividend for half-year to Dec. 31, 1894. at 6 per cent. per annum, £8,985; less income tax, £299. 9s. 9d.	8,685 10 3	
		980 18 3
Balance from revenue account		28,962 19 4
Interest received and accrued		9 7 0
Rents received and accrued		989 4 8
		£30,942 9 3

GENERAL BALANCE-SHEET, DEC 31, 1895.

Dr.	£ s d.	£ s. d.
Capital account		440,000 0 0
Sundry creditors		4,305 11 1
Debenture interest accrued	£2,323 10 0	
Less income tax	77 9 0	
		2,246 1 0
Unclaimed dividends		21 11 8
Depreciation account		18,601 0 0
Sinking fund		4,832 11 6
Reserve fund		8,332 14 10
Net revenue account	23,731 11 9	
Less interim dividend to June 30, 1895, at the rate of 5 per cent. per annum, £7,887. 10s.; less income tax, £262. 18s. 1.	7,624 11 11	
		16,106 19 10
		£494,446 9 11

Cr.	£ s. d.
Capital account	443,843 14 11
Stores in hand	1,144 5 6
Sundry debtors	24,805 14 1
Cash at bankers (Messrs. Barclay, Ransom, and Co)	13 440 9 6
Cash in hand	26 6 4
Deposits with vestries, etc.	357 7 0
Preliminary expenses and suspense account	£5,555 12 7
Less amount written off for the year 1895	2,500 0 0
	3,055 12 7
Investments at cost	7,773 0 0
	£494,446 9 11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC, YEAR ENDING DEC. 31, 1895.

Board of Trade units generated		3,371,327
Quantity utilised:		
Sold to consumers	2,830,396	
Used on works for lighting, meter testing, etc.	52,281	2,882,677
Quantity expended in distribution:		
In batteries	18,595	
In feeders	395,653	414,248
Total quantity accounted for		3,296,925
Quantity unaccounted for		74,402
Number of lamps on circuit, December 31, 1895		210,982

CUBA SUBMARINE TELEGRAPH COMPANY, LIMITED

The ordinary general meeting of this Company was held on Wednesday at Winchester House, E.C.

Mr. C. W. Parish presided, and moved the adoption of the report. The sum of £10,000 had been added to the reserve fund, and the directors, he said, recommended a dividend at the rate of 8 per cent. per annum, the balance of £3 719 being carried forward. In consequence of the insurrection in Cuba, which still continued, the Spanish Government had made certain proposals to the Company, which had resulted in the Company obtaining a concession to lay a cable between Cienfuegos, Casilda Tunas Jucaro, Santa Cruz, and Manzanillo, with a subsidy of £2,000 per annum from January 1, 1896 till August 27, 1910, which was the date when the original concession would expire. This cable had been successfully laid by the contractors and duly taken over by the Company.

The report was adopted.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: John D. Milburn, Esq. (chairman), the Hon. C. A. Parsons (managing director), Sir B. C. Browne, Colonel W. M. Angus, Colonel H. S Dyer, John B. Simpson, Esq. Jas. Patterson secretary. W. D Hunter engineer.

Report of the directors submitted to the shareholders at the ninth ordinary general meeting held at the Station Hotel, Neville-street, Newcastle-upon-Tyne, on Tuesday, Feb. 11:

The directors have pleasure in again reporting that the supply of current continues to give satisfaction to the Company's consumers. The installations connected to the Company's mains during the year are equal to 3,200 10-c.p. lamps, bringing the total up to about 24,700, and 471 662 units of electrical energy have been supplied, as against 431,239 units supplied in 1894. During the past year 1 650 yards of main and branch piping have been laid, together with 3,771 yards of main and branch cable. The condensing plant continues to work satisfactorily, and your directors anticipate making other improvements with the object of still further reducing the cost of production. The gross earnings during the year amount to £4,302 9s. 11d., and after paying interest, and making provision for depreciation, and writing off the balance of formation expenses (£563), your directors are able to recommend a dividend at the rate of 4 per cent. for the half-year ending December 31 (less income tax), which, together with the interim dividend paid in July last, makes the dividend 6½ per cent. for the year. Sir B. C. Browne and Colonel H. S. Dyer retire by rotation, but are eligible, and offer themselves, for re election as directors. The auditors, Messrs, Strachan and Co., also offer themselves for re-election.

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Dr. BALANCE SHEET, DEC. 31, 1895.

	£	s.	d.
Capital—10,000 shares of £10 each	100,000	0	0
5,000 shares, £8, called up	40,000	0	0
Debentures	8,900	0	0
Loans £7,200 0 0			
Creditors 817 18 4			
Bankers 1,463 0 5			
	9 480	18	9
Reserve fund as per last balance-sheet 708 0 0			
Add premium on new shares 10 0 0			
	718	0	0
Profit and loss account—profit for year ending December 31, 1895 2,460 5 9			
Add balance from last year 223 3 1			
2 683 8 10			
Deduct interim dividend paid 966 12 7			
	1,716	16	3
	£60,815	15	0

Cr.

	£	s.	d.
Buildings and plant, pipes and cables (including cost of laying), meters and transformers, electrical instruments, etc.—amount expended to date	56,496	13	1
Less depreciation fund	3,000	0	0
	53,496	13	1
Debtors for amounts paid on account of contracts in course of completion	2,250	0	0
Office furniture	152	15	10
Stock of stores, etc.	263	8	11
Cost of license, provisional order, etc.	581	16	10
Formation expenses as per last balance-sheet, £500; expended since, £63 £563 0 0			
Less amount written off 563 0 0			
Debtors for current, etc., supplied to December 31, 1895 (less reserve for discounts)	4,038	10	11
Cash in hand	32	9	5
	£60,815	15	0

PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1895.

Dr.

	£	s.	d.
Wages, salaries, rent, rates, taxes, and directors' fees	2,687	15	9
Stores, fuel, water, etc.	1 609	9	6
Repairs and renewals	246	18	7
Stationery and general expenses	156	15	0
Balance carried down	4,302	9	11
	£9,003	8	9
Interest on debentures and loans	£549	4	2
Formation expenses written off	563	0	0
Transferred to depreciation fund	730	0	0
Balance carried to balance-sheet	2 460	5	9
	£4,302	9	11

Cr

	£	s	d.
Electric energy supplied, less discounts	8.490	0	2
Meter and transformer rent	510	18	7
Transfer fees	2	10	0
	£9,003	8	9
Balance brought down	£4,302	9	11
	£4,302	9	11

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Parma (Italy).—The municipal authorities of the city of Parma desire tenders by February 25 for the electric lighting of the city from June, 1897, to 1912.

Beziers.—Offers are wanted by February 15 for a concession for an electric tramway, about 8,800 metres (5½ miles) long. Particulars at the Mairie, Beziers, France.

Manuel.—Offers are wanted for the electric lighting of the town of Manuel, in the province of Valencia, Spain, for 15 years. Number of inhabitants, 1,500. Price suggested, 1,500 pesetas, payable monthly.

Belper.—The gas company are considering the setting up of an electric lighting plant, and electrical contractors can obtain information as to it on application to the Managing Director, Gas Company's Offices, Belper.

Teneriffe (Canary Islands).—Tenders are invited for the electric lighting of the town of Santa Cruz, Teneriffe, for a period of 35 years. Particulars can be obtained at the Ministerio de la Gobernacion, Madrid, and tenders must be delivered by February 29.

Brunn (Austria).—The Municipality desire offers for the construction and working of a central station for the supply of electric energy for lighting the town, for power, and if required, for running a tramway. Tenders must be sent before March 31 to the Bürgermeister, Brünn, Austria, from whom particulars can be obtained.

Sunderland.—The Town Council ask for tenders for two continuous current dynamos and engines, three Babcock and Wilcox boilers, an economiser, and water softening plant. Particulars can be obtained from the borough electrical engineer at the electrical supply station, Sunderland, upon depositing £1. 1s, and tenders must be in by March 13

Paris.—The French Telegraphic Department offer for tender on February 27 the supply of 125,000 kilogrammes of bronze or copper wire and on February 28 a telephone cable and materials for telephone batteries. Applications for permission to tender must be made to La Direction Générale de postes et des télégraphes by February 17 in the first case and February 18 in the second.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grange-town, Yorkshire, to whom the plans, etc., must be sent by May 1.

Bridlington.—The Bridlington Urban District Council invite tenders for the lighting of the public streets and places within the district of the Council for one year, from March 31, 1896, in accordance with certain conditions which may be seen on application to the surveyor, Prospect-place. Tenders to be sent to Mr. Chas. Gray, clerk, Bridlington, marked "Tender for Lighting," by 17th inst.

Menston (Yorks).—Tenders are invited for the supply of telephones and electric bells for the new buildings and houses upon the estate, for the Committee of the West Riding Asylum, Menston. The specification may be seen at the county surveyor's offices, Wakefield, and at the clerk of works offices at the asylum. Tenders to be delivered to the office of Mr. J. Vickers Edwards, county surveyor, Wakefield, by 17th inst.

Keighley.—Tenders are invited for providing and fixing telephonic communication between the various buildings forming the infectious hospital now in course of erection at Morton Banks, near Keighley, for the Keighley and Bingley Joint Hospital Board. The buildings and plans can be inspected on application to Mr. Alfred Moore, clerk of the works at the hospital. Tenders, marked on the outside "Tender for Hospital Telephones," will be received by Mr. Geo. E. Spencer, clerk, North-street, Keighley, not later than noon on March 4.

Brussels.—The Belgian State Railways are offering for tender the work necessary for the alteration of the conductors and wiring for the electric lighting of the Marbehan Station. The contract is part of a rearrangement of the water supply, and particulars are obtainable at the Bureau du Chef du Service, Arlon, Rue de la Station, 26 Tenders must be in by February 20. Tenders are also required by February 19 for the supply of a large quantity (78 lots) of materials for the Belgian Telegraphs. Particulars can be obtained at the Brussels Bourse.

Islington (London).—The Vestry of St. Mary, Islington, invite tenders for electrical engineers' stores, etc. Forms of tender and further particulars may be obtained, and the draft contract inspected by application, between 10 a.m. and 12 noon, at the Vestry Hall, Upper-street, N. No tender will be received after 12 noon on 27th inst. Persons tendering must be prepared with a £10 note, to be deposited (not enclosed with the tender), as a guarantee of good faith until the execution of the contract. Those tendering for more than one of the items must enclose each tender in a separate cover, and be prepared to deposit a separate £10 note with each tender. Each cover must be properly endorsed.

RESULTS OF TENDERS.

Southport.—The Town Council have accepted the tender of Messrs. E. G. Pulford and Co. for fitting up a new telephone system at £397 10s.

Birkenhead.—The Corporation have accepted the tender of Messrs. Drake and Gorham, 66, Victoria-street, London, S.W., at £215, for the wiring of the town hall for electric lighting.

Maidenhead.—The following tenders were received for carrying out certain electric bellwork at the School for Technical Instruction: C Batting, Maidenhead, £8 15s.; Pearse, Maidenhead, £5. 15s.; Bloomfield, Maidenhead, £5. 10s. 6d. (accepted).

Shoreditch (London).—The following tenders have been received by the Shoreditch Vestry for the proposed electric lighting buildings (boiler-house and engine-room), at Pitfield-street, Hoxton:

Nightingale, Albert-embankment	£10 494	0	0
Manlove, Alliott, and Co, Limited, Nottingham	10 540	16	0
Shelbourne and Co, Fenchurch-street	10 005	5	9
Kirk and Randall, Woolwich	9,442	0	0
Jarvis and Sons, Hackney-road	9 926	0	0
Chessum and Sons, Haggerston	9,499	0	0
Wilkinson Bros., Finsbury Park	9,971	0	0
Coulsell Bros, Bethnal Green	9,383	0	0
Pattinson and Sons, Whitehall	8,854	0	0
Atherton and Dolman, Poplar (accepted)	8,535	0	0

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Southport.—The following tenders have been received for the electric lighting and fittings to same at "Belle Vue," Southport, for Sir George A. Pilkington, J.P., and C.A. (Mr. C. Sydney Ingram, architect) Specification by the architect:

G. Hill and Co., Manchester	£345	3	0
Liverpool Electric Supply Company	340	0	0
Manchester Edison-Swan Company	304	11	6
Verity and Co., Manchester	293	6	0
Albert Maund, Southport (accepted)	283	0	0

St. Pancras (London).—Tenders for the wiring and other work in connection with the electric lighting of the Vestry Hall and offices in Pancras-road, for the St. Pancras Vestry, have been received as follows:

Maple and Co., Limited	£553	11	3
Roger Dawson, Limited	528	15	8
H. F. Joel and Co.	477	7	10
H. Binks and Co.	449	16	6
Rashleigh Phipps and Co.	445	0	0
Vaughan and Brown	440	0	0
E. P. Allam and Co.	438	0	0
Benham and Son, Limited	437	7	2
J. Sax and Co., Limited	436	7	2
Pettit and Hards	426	0	0
Strode and Co.	419	10	6
J. W. Whitaker	404	16	0
Spagnoletti and Crookes	399	4	6
Drake and Gorham	396	16	8
Electrical and Engineering Company	388	15	0
W. Whiteley	382	11	7
Graham and Biddle	374	1	5
Hollingham and Saward	272	10	6
Fowler, Lancaster, and Co., Limited	372	7	9
Thorpe and Waring	350	10	0
Carter Bros.	340	5	0
P. Jones	836	17	0
C. A. Hemingway	333	8	6
L. Alwyn	331	0	0
Laing, Wharton, and Down	304	6	6

The tenders were referred back to committee.

BUSINESS NOTES.

Prestwich.—The Urban Council have decided to issue circulars to ascertain the probable demand for electric light.

Hove.—The workrooms at the new laundry are fitted, like the baths, with electric light generated on the premises.

Hull.—Dr. Holden has tendered his resignation as chairman of the Electric Committee, on account of his health and professional work.

Budapest.—The Ungarische Elektricitäts-Gesellschaft report a profit balance of 615,476 gulden, and the Board recommend a dividend of 5½ per cent.

Kettering.—By 16 votes to 4 the Board of Guardians decided that the telephone at the workhouse should be connected with the National Telephone Company's exchange.

Grimsby.—The Town Council's provisional order for electric lighting expires next April; Mr. Barrett has therefore given notice to bring the matter before the next meeting.

Electric Lighting of Railway Carriages.—The Great North of Scotland Railway Company are having their carriages fitted with the electric light apparatus invented by Mr. Arthur B Gill.

Morley.—At the Town Council meeting, a letter from the Tradesmen's Association on the lighting of Queen street and the business premises in that street with electricity, was referred to the Gas Lighting and Electric Lighting Committee for consideration.

Hackney (London).—The Vestry have adopted a scheme of electric lighting in combination with a dust destructor. The capital outlay will be £80,000, but it is estimated that the parish will reap a profit.

Renfrew.—The Town Council are taking steps to light the burgh. The terms asked by the Paisley Council are too heavy, but the latter body has decided to hold a special meeting to consider the matter.

Walsall.—The Electric Lighting Committee have reported that during the month the total number of customers supplied was 45, the number of units consumed during the month being 5,230, and the income therefrom £130. 15s.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending February 9 amounted to £1,090, as compared with £859 in the corresponding week of the previous year, being an increase of £231.

Morecambe.—An agreement for the purchase of the Morecambe Electric Light and Power Company's undertaking and plant for £3,897 has been executed, and the chairman of the District Council has been empowered to convene a public meeting to ratify the same.

Telegraph Construction and Maintenance Company, Limited. The directors have decided, subject to the audit of the accounts, to pay a dividend of 10 per cent., or £1. 4s., per share, in addition to the 5 per cent. already paid, making 15 per cent. for the whole of 1895.

Horfield.—At the meeting of the Urban Council, Mr. A. G. Stennard moved that a committee be formed to take into consideration the best means of lighting the district with electricity. Mr. W. Maggs seconded. The resolution was carried, and a committee was formed.

Fort William.—The ceremony of cutting the first sod of the lade which is to supply the water for generating electricity to light the burgh of Fort William was performed on Tuesday afternoon in a field on the banks of the River Krachnish, about three miles from Fort William.

Bradford.—The Gas and Electricity Supply Committee of the Corporation have received permission from the Finance Committee to present an application to the Local Government Board for power to borrow the sum of £40,000 required for the extension of the electricity works.

Darlington.—Serious complaint having been made in the east end of the town owing to the erection of telephone poles on the main roads, in some cases close in front of shops and houses, the matter was referred to at the Town Council meeting and referred to the Streets Committee.

Halstead.—At a meeting of the District Council, the surveyor read a report of the committee recommending that Messrs. Crompton and Co., of Chelmsford, be asked to send down an engineer to report as to the lighting of the town by electricity, at a charge of 10 guineas. This was agreed to.

Kirkby Lonsdale.—At the meeting of the Urban Council a letter was read from Mr. Harris stating that he intended to carry a wire from the old corn mill in Mill Brow to Lunefield, and asked if the Council would make any objection. The Council granted permission, providing it was placed at the proper height.

Macroom (Cork).—For some time past electrical engineers have been at work on the premises of Messrs Baldwin and Co, Limited, Macroom, for the purpose of lighting up the premises with electric light. Several shopkeepers in the town have signified their intention of introducing the light into their shops and premises.

Cambridge.—The contract for public lighting expires in May next, and the clerk was asked at the Urban Council meeting whether the Cambridge Electric Lighting Company had power to light Chesterton, or, if not, could the Council confer power? The Clerk said he could not answer the question without reference.

Mason College Chemical Society.—At the meeting of this society at Birmingham, Prof. Percy Frankland in the chair, Dr. T. S. Patterson read a paper entitled "The Electrolytic Dissociation Theory in its Relation to Analytical Chemistry." A discussion followed, in which Dr. Boyd, Dr. Baker, and Mr. Macgregor took part.

Harrogate.—The electric lighting cable has been laid. The electric lighting plant will be located on the irrigation farm, which is the property of the Corporation, and the motive power will be derived chiefly from refuse destructors, which are intended to be erected, and by this means considerable economy of fuel will result.

City and South London Railway.—The returns for the week ended February 9 were £972, compared with £1,022 for the corresponding period of last year, being a decrease of £50. The total receipts for the half-year terminating as above were £5,997, compared with £6,041 in the same period of the preceding year, being a decrease of £44.

Bedford.—The Corporation have decided to borrow a further instalment of £12,500 (on account of the loan of £27,000 already sanctioned) for carrying out the following scheme—for public lighting only, £1,000; private lighting in specified streets, £8 750; machinery at central station, £2,500; contingencies, £250—estimated cost, £12,500.

Keswick.—Application has been made to the Board of Trade for an electric lighting provisional order by the Urban District Council, and the Keswick Electric Lighting Company, Limited, ask for similar powers, including in their scheme the supply of electricity to St. John's, Castlerigg, and Wythburn-under-Skiddaw and Above Derwent.

Newport (Salop).—At a meeting of the Council Councilor Smith presented a petition asking the Council to consider the advisability of using electric light in the district. Councillor Boughey opposed it—first, because the question had been considered and decided against, and, secondly, because the Council had the great matter of sewerage before them.

South Staffordshire Tramways Company, Limited.—The action brought by this Company against Messrs. Ebbsmith and Wain to recover alleged secret profits, and for the rescission of contracts made while the defendant Wain was manager of the Company, was commenced before the Lord Chief Justice and a special jury in the Queen's Bench on Wednesday.

Garston.—At the Urban Council meeting a memorial was submitted from residents in the districts asking the Council to support the application of the Liverpool and District Lighting Company for powers to supply electricity in the district. The law clerk was instructed to consult with the law clerks of the Much Woolton and Allerton District Councils upon the question.

Telegraph Extension.—Lord Balfour of Burleigh has informed a deputation which waited on him from the Ross-shire County Council that he had been in communication with a representative of the Treasury on the subject, and he hoped the result might be that not only would they have a small sum for expenditure upon roads this year, but also a small sum for the further extension of telegraphs.

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The "Dover."—This new paddle-steamer, built for the London, Chatham, and Dover Company for the Dover and Calais route, is lighted throughout by electricity on the Edison-Swan system, the plant and fittings being supplied by that company, and fitted by the shipbuilder's electrical department. Besides the internal lights, there are four large embarkation lamps.

Loughborough.—The borough surveyor has made a further report as to the installation of the electric light at the sewage-disposal works, in which he recommends that a C2 friction driving plant which the Brush Company offered to sell to the Corporation for £100 be acquired, instead of the dynamo and engine which it was decided to purchase at the last meeting, so that a larger output might be obtained. The Town Council have adopted the recommendation.

Redcar.—It is reported that the lighting of the town by electricity, about which so much was said a few months ago, is not likely now to be carried out, as Mr. Stacey, of Sheffield, the engineer who proposed to undertake the work, has abandoned his scheme because of the very poor support he had received from the Redcar people in his endeavour to float a company to carry out the business.

Dover.—The town clerk, as requested, reported to the Town Council that there were 21 electric lamps on the sea-front and up to the Market-place, and which had cost £630. Extra arc lamps were agreed to be supplied at £30 per year per lamp. Already there were 10 extra lamps in Snargate street at a cost of £300 per year. The question of improving the form of lamp-post was referred to the Lighting Committees.

Bath.—It is intended to light the G.W.R. station by electricity, and the company are about to erect a building to receive the necessary apparatus. Mr. Gatehouse having reported to the Council that during the fortnight 13 lamps had been out, but the lighting on the whole had been steady, Mr. Phillips remarked that during the last two or three days it had been anything but steady—it had been very "groggy."

Bristol.—Since the opening of the electric tramway a number of deputations from various corporations in the kingdom have visited the city for the purpose of inspecting the line. In the report of the Bristol Tramways Company for the half year ending December 31, reference is made to the opening of the electric tramway between Bristol and Kingswood, and it is stated that the working has proved very satisfactory.

Cardiff.—On the western side of the new exhibition, buildings are now being erected to contain the electric lighting engines and dynamos, as well as the boilers for motive power for the various purposes of the exhibition. The machinery section will be located in a building about 260ft. in length by 80ft. in width, whilst the mines, mining, and horticultural sections will find a home in a somewhat similar-sized building adjoining.

Fowler-Waring Cables.—The new Company has been registered, with a capital of £200,000 in £5 shares, to acquire as a going concern the business of the Fowler-Waring Cables Company, Limited (incorporated in 1889), together with all the property, assets, and liabilities. The first directors are Messrs. W. Fowler, W. Chamberlain, G. Fleming, Lord Medway, and Mr. G. F. Smart. The registered office is 32, Victoria-street, S.W.

Colchester.—The Town Council have appointed an Electric Lighting Committee and have engaged Mr. Massey, as consulting electrical engineer, to prepare a statement of the general outlines of a scheme, and to consider, report, and advise upon schemes and tenders, based upon such outlines, to be obtained by the Council from four firms of electrical engineers for lighting a definite area and for superintending the construction of the works.

Blackburn.—The Gas Committee's minutes, which have been passed by the Town Council, stated that the town clerk had reported that the Hopkinson patent rights in respect of the three-wire system would expire this year, and that the patentee was applying for a renewal of the patent. It has been resolved that it be an instruction to the town clerk, if the Corporation have a *locus standi*, to oppose the renewal of the patent rights.

Lincoln.—The Special (Electricity) Committee have met and considered the resolution of the Council appointing it and the letters and reports on the subject of electric lighting from various bodies and persons. Each member of the committee was requested to obtain as much information as possible as to the mode in which existing electrical works are constructed, so that further material might be placed before the committee at a future meeting.

Kidderminster.—Alderman Parry moved certain formal resolutions at the Town Council meeting relative to the action of the Council with regard to the proposed electric tramway between Kidderminster and Stourport. He pointed out that it was not intended to offer any opposition to the company's Bill in Parliament if the conditions agreed to by the company with the Council were adhered to, but the object of the resolutions was to give the Council a *locus standi* to oppose the Bill if necessary. The resolutions were carried.

Catalogue.—We have received a copy of Messrs H. M. Salmony and Co.'s illustrated 1896 catalogue. The company's electrical engineering works are at Notting Hill, W., and the offices at 61, Charing Cross-road. In consequence of the great demand for their instruments and accessories, the firm have been compelled to transfer the manufacture of accessories to separate works at Cheapside, Birmingham, where they have laid down plant of an extensive character.

City of London Electric Lighting Company.—The directors of the City of London Electric Lighting Company, Limited, have decided to recommend the payment of a dividend, subject to the completion of the audit, of 6s. per share on the preference shares for the second half of 1895, making, with the interim dividend already paid, a total distribution of 6 per cent. for the whole year; and of 10s. per share on the ordinary shares for the 12 months, being at the rate of 5 per cent. per annum. The transfer books and registers will be closed to 21st inst. inclusive.

Huddersfield.—The town clerk (Mr. F. C. Lloyd) has read a communication to the Electric Lighting Committee which he had received from the Local Government Board sanctioning an application of the Corporation for power to borrow £50,000 for the purpose of extending the electric lighting works and plant of the Corporation the amount to be repaid in 25 years. The previous loans on electric lighting account amount to £50,000, of which £12,000 is to be repaid in 30 years and £38,000 in 15 years.

Newcastle-on-Tyne.—At the last meeting of the City Council the Mayor moved that the Council petition Parliament to insert in the Bill regarding the tramways an additional power enabling them to work any or all the tramlines by electricity. The petition was adopted, as was a motion asking to have the time specified for the completion of the lines extended from three to five years. A deputation of members of the City Council has visited Edinburgh for the purpose of obtaining information with regard to the cable system of tramways.

Edinburgh. - On the representation of the chief constable, the Plans and Works Committee have recommended the installation of the electric light in the police cells at a probable cost of £180. The Town Council, at a special meeting, have resolved to join the Corporations of Edinburgh, Glasgow, and Belfast in opposing an application by the Westinghouse Electric Company for an extension of their three-wire patent. If the patent is extended the annual charge to Aberdeen, in which there are already 100 tons of the wire laid, would be £250.

Croydon.—The Electric Lighting Sub-Committee have reported that the chairman submitted a plan showing the proposed method of public lighting in the compulsory area. This plan provides for the erection of arc lamps in Katharine-street, Park-lane, Mint-walk, from Scarbrook-hill to West Croydon Station, Poplar-walk, Station-road, St. Michael's-road, part of Wellesley-road, George-street, Church street, and from Crown-hill to Pitlake. The estimated extra cost of these lights over the price now paid for gas lamps in the above area is from £300 to £400 per annum. The matter is being further considered.

Worcester.—At the meeting of the City Council, Alderman Williamson moved a recommendation of the Electricity Committee that the Council should make application to the Local Government Board to sanction a further loan of £5 000 for electricity purposes, for the purpose of defraying the expenditure incurred and now being incurred under the following heads, and to be repayable in 30 years—namely, generating station, £450; generating plant, £1,000; distributing and other plant, £920; extensions of mains, £2 520; street-lighting, £110. The motion was carried.

Douglas (Isle of Man).—Operations have been commenced on the undertaking which will add another electric tramway to the transport system of the island. This is called the Douglas Head Electric Tramway, and it is being carried out under the superintendence of Mr. W. L. Fletcher as resident engineer. In the common-law division of the Manx High Court, the action of George Crellin against the Isle of Man Tramways and Electric Power Company to recover damages for injuries sustained while travelling as a passenger on the company's electric car system, is stated to be settled. It is understood plaintiff is to receive £250 and costs.

Bradford.—The Gas and Electric Supply Committee request the Town Council to authorise the presentation of a memorial to the Local Government Board for power to borrow the sum of £40,000 required for the extension of the electricity works consequent upon the increasing demands for supply of electricity. The committee also recommend the acceptance of the tender of Messrs. Siemens Bros. and Co., Limited, for the supply of two dynamos required at the proposed new electricity works in Valley-road for £2,650, and the tender of Messrs. Willans and Robinson, Limited, for the supply of two 600 i.h.p. steam-engines required at the same works for £4,400.

South Staffordshire Tramways.—At a meeting of the West Bromwich Town Council the Highway Committee reported that up to the present they had not received any new proposal from the tramway company as to a new method of traction, but they were prepared to consider any scheme that might be submitted. Mr. Lawley remarked that he believed there was likely to be more competition for a cable tramway. One or two firms were prepared to lay down a good service, and it was their duty to see that they got the best system. He had seen the plans prepared by electrical engineers in Birmingham for a complete system, embracing the latest improvements.

Ambleside.—The Windermere and District Electricity Supply Company, Limited, seek power to produce store, and supply electricity, etc., within the district of the Urban District Council. At a meeting of the Council the report of the Electric Lighting Committee was read, and Mr. Huddlestone explained that the result of the committee meeting was that they were forced into making application for a provisional order. The Council would not be bound to take it up for two years. The Chairman remarked that the Council would not be bound at the end of that time to have their own electric works. The members being of opinion that the committee had done the best they could, the report was adopted.

Altrincham.—At a meeting of the Urban Council it was resolved to go into committee on the question of electric lighting at

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Ashton-on-Mersey and Timperley. The clerk (Mr. Stokoe) laid before the Council a proposition from the Altrincham Electric Supply, Limited, for the lighting of these districts. The matter was then considered, and it was resolved, "That the clerk be instructed to inform the Board of Trade of the agreement between the Electric Supply Limited, and the local authorities now in existence for the purchase of the present works, and to ask that such clauses may be inserted in the proposed order as will protect this Council in the event of their deciding to purchase under the said agreement."

Tape Prices.—In the case of Cochrane *v.* the Exchange Telegraph Company, in which the plaintiff sued the company for default in supplying tape prices of Stock Exchange quotations, Mr. Justice Chitty has found that with regard to two instruments they were held on contracts which could be determined on reasonable notice, which he held under the circumstances to be three months' notice, and in respect to these the plaintiff was entitled to damages for breach of contract, which he assessed at £50, but not to an injunction. As to the third instrument, it was held under a contract which made its use subject to conditions imposed by the Stock Exchange, and the plaintiff had no cause of action. No costs were given to either side.

Wolverhampton.—The directors of the Electric Construction Company, Limited, have commenced additions to their large depôt situated at Bushbury, near Wolverhampton, from plans and specifications prepared by Mr. A B. Blackburn, civil engineer. The office arrangements have already been extended, and employment is now given to upwards of 600 hands. The site of the operations now going on adjoins the west side of the present main shopping, at the junction of the Stafford-road and Showell-road, and comprises over an acre of land at the rear of Gorsebrook House, Gorsebrook The total cost of the extensions and alterations, including the extra tools and machines, is estimated at £10,000, which the directors are prepared to vote forthwith.

Clacton-on-Sea.—At the Urban District Council meeting, Mr. Murray moved a resolution that an advertisement be inserted in the electrical papers to the effect that the Council were open to receive estimates of the cost of plant, etc., for the installation of electric light in the town. He thought it was only right to go in for the best light possible The new electric light would be from 2½d. to 3d. per Board of Trade unit, which would be about the same as gas at 5s. per thousand. The prime installation he estimated at from £10,000 to £12,000. Mr. Revell seconded. An amendment that it be referred to the Lighting Committee for enquiry and report was moved by Mr. Baker and seconded by Mr. Schulkins. The amendment was carried, eight voting in favour and two against.

Greasborough.—At the meeting of the Urban District Council it was stated that Messrs. Young, Wilson, and Co., Sheffield, the solicitors to the promoters of the Sheffield District and Rotherham Tramways, had written to the clerk, Mr. Edward Jackson, as under: "We regret to inform you that owing to the action of the Sheffield Corporation, and to the difficulties which have arisen in connection with that portion of our clients' tramways scheme which extended from the city boundary to Rawmarsh, our clients have been reluctantly compelled to withdraw their scheme for the present session. In doing so, they desire us to thank your Board and yourself for the courtesy which you have extended to them during the negotiations which have taken place with reference to the project."

Hammersmith (London).—The Electric Lighting Committee reported at the Vestry meeting that they were in possession of the necessary information as to the space required for the generating station in Fulham Palace-road, and, having been advised that it is important to prepare for the erection of the buildings as soon as possible, they instructed the surveyor to invite tenders for the excavation and carting away of the soil. For the carrying out of this work the tender of a Mr. Greenham was accepted, and the committee recommended that the surveyor be instructed to prepare the necessary plans for the buildings. Mr. Glasier objected to the recommendation on the ground that the surveyor had already sufficient to do. Mr. Payne expressed a similar view, contending that the work should be carried out by the usual professional men. After some further discussion the recommendation was agreed to.

Glasgow.—The sub-committee on electric lighting have submitted a report on their recent visit to Edinburgh. After describing the chief features of the Edinburgh installation, and pointing out wherein they differ from those of Glasgow, the committee conclude by stating that, as the result of their inspection, they found that the street-lighting of Edinburgh is much better than the street-lighting in Glasgow, and that that result had been obtained by a more judicious employment of the light. They ask that the matter be remitted back to them to consider and report as to what measures are necessary to improve the present system of the electric lighting of the streets of the city, with power to confer with the Electric Lighting Committee of the Corporation. The committee on the electric lighting of the city suggest that the electric light and gas departments should be separated. This has been agreed to.

Reading.—The secretary of the Reading Electric Supply Company having written that the mains were now laid in the various streets forming the centre of the town, the Town Council have resolved to ask for particulars of the cost of supplying the current to the public lamps in the area referred to. The following motion was proposed by Mr. Simmons, according to notice: "That the Highways and Lighting Committee, or a sub-committee to be appointed by them, be requested to confer with the Reading Tramways Company, Limited, with a view to ensuring an immediate improvement of the tramways and the mode of working the same." He was under the impression that if the company were approached they would be inclined to spend £40,000 or £50,000 in extending the lines to Whitley and Caversham, and in improving them, and would perhaps adopt electric cars, and they might do the improvements better than the Corporation. The resolution was lost.

Neston.—The electric light question has caused one member (Mr Grenfell) of the Urban Council to send in his resignation. Mr Grenfell had suggested that they should adopt the electric light and it was proposed that the sub-committee should be empowered to spend 20 guineas for the purpose of enabling them to secure an engineer to draw out a plan of the district, and to prepare estimates, but the sub-committee never went any further. Mr. Jamieson said only about 60 ratepayers had expressed themselves in favour of taking the light, and therefore it would have been madness for the sub-committee to go on with the scheme In their report they stated that if the Council were not satisfied with the financial aspect of the matter they should drop it. It had dropped for the present, but it would be revived again. He could not see how the sub-committee were to blame in the matter It was eventually decided by a unanimous vote to ask Mr. Grenfell to reconsider his decision.

Blackpool.—The following are the minutes of the Electric Lighting Committee which came up for confirmation at the Town Council meeting: January 25.—Resolved, that consequent upon the resolution of the Council on January 7, 1896 as to alterations of discounts on supply of electrical energy, the town clerk be instructed to give due notice to the Blackpool Winter Gardens and Pavilion Company, Limited, to cancel the existing agreement as to supply of electrical energy, and that the town clerk be requested to communicate with the company thereon as now directed. Read letters of December 18 and 30, 1895, from Messrs. Dean and Waterhouse as to the supply of electrical energy to premises occupied by Mr. John Taylor. Resolved, that the consideration of such letters be deferred until the next monthly meeting. The borough electrical engineer reported that he had visited Leeds, as instructed by the committee on January 14, 1896, and inspected a new vertical 300-kilowatt engine, running at the works of Messrs. Fowler and Co., Leeds.

Tunbridge Wells.—The report of the Lighting Committee, which was read at the Town Council meeting, and the adoption of which was moved by Councillor Wood, set forth the continued progress of the electric lighting system. Councillors Jenkinson, Strange, Penn, and Gower instanced parts of the town where more light was needed, such as St. James's-road, Beulah-road, Albion-road, etc, and the committee promised to consider the suggestions as to the side streets and suburbs. Councillor Strange raised objections to certain Corporation information on electric lighting questions getting into newspapers long before such matters came before the Lighting Committee. He asked who supplied this premature information. Did any members of the committee give this information? If so, this could not be right. Councillor Wood, as the chairman, and other members of the committee, disclaimed all knowledge of how the information appeared in the Press, and the subject dropped. The Corporation have decided to raise £25,000 for electric lighting purposes.

Newport (Mon.).—At the meeting of the County Council the Electricity Committee reported in favour of seven suburban roads being included in the extension of the electric system, but with reference to the purchase of meters they thought it desirable these should remain the property of the Corporation. Mr. Morgan wanted to know when Maindee was to have the light, and Alderman Moses replied that the committee would be prepared to extend the mains to Maindee as soon as there was a demand made for a supply. Mr. Proctor Eeles said he saw by the estimate for the ensuing six months that the income from the electric light was estimated at £1,000 and the outlay at £1,805. That involved a loss of £1,600 per annum to the ratepayers, and he wished to know when the chairman anticipated the light would be worked with some profit. Alderman Moses said that most new undertakings were for some time non-paying. The undertaking was now paying its way better than before, because the consumption was increasing. The report was afterwards adopted.

New Company.—The Cox Thermo-Electric Company, Limited, has been registered with a capital of £100,000 in £10 shares. The objects are stated to be to acquire any patents, patent rights, licenses, concessions, and the like, and in particular any inventions relating in any way to the direct generation of electricity from heat by means of thermopiles, or thermo-electric generators, or to the construction, maintenance, improvement, or working of thermopiles or thermo-electric generators of any kind; with a view to the above objects to adopt and carry into effect the agreement referred to in Clause 3 of the company's articles of association expressed to be made between H. B. Cox, R. W. Wallace, and F. J. Webster of the one part, and this company of the other part; and generally to carry on business as manufacturers of and dealers in thermopiles and thermo electric generators; as mechanical engineers, dynamo builders, builders of cars, vans, carriages, and vehicles of every description; as suppliers of electricity; as manufacturers of and dealers in all kinds of electrical appliances; and as metal founders.

Bromley.—At the meeting of the Urban District Council the Standing Orders Committee reported that, in accordance with the reference of the Council made on November 26, they had received a deputation from the committee represented by Messrs. Waterer and Dickins in reference to the acquisition of the electric lighting

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provisional order. As a result of such meeting, Messrs. Waterer and Dickins submitted a formal enquiry as to whether the Council would be disposed to hand over its powers and interests in the provisional order, provided the corporation which must be formed were willing to agree as to any reasonable conditions as to providing public lighting, and giving the Council the option to purchase the undertaking at any period within seven or 14 years at a price to be fixed by arbitration, or in some other way agreeable to the Council. The committee recommended that a reply be sent that the Council would only be prepared to hand over the provisional order to an approved local corporation on the undertaking to pay the cost of and incidental to obtaining that order. The report was adopted.

Chesterfield.—At the meeting of the Town Council the Mayor moved: "That the resolution passed by the General Purposes Committee on January 15, 1894, and confirmed by the Council on February 13, 1894, by which the National Telephone Company were to be charged 7s. 6d. per pole for each telephone pole standing in either the streets or public thoroughfares in the borough or on Corporation property be rescinded." The motion was seconded. Alderman Wood opposed, in favour of the original proposition. The time was probably not far distant when the town would be lit by electricity, and if they allowed that private trading company to put their wires indiscriminately along their main thoroughfares they might depend that the company as a money speculation would so arrange their wires that it would be impossible for the Corporation or anyone else undertaking to light the town with electricity to put up their wires unless they first paid out the company's rights. The resolution was carried by 13 to 5, and it was decided that in future the payment be 1s. per pole per year.

Dungannon.—At a meeting of the Town Commissioners, the following resolution was unanimously adopted: "That, having read the communication of this date from Mr. C. M. Wilson, intimating his intention to apply to the Board of Trade for an order, *inter alia*, authorising him, or such other persons as may be associated with him, to promote, undertake, and establish works for the supply of sufficient electrical energy under and in pursuance of the provisions of the Electric Lighting Acts, 1882 and 1888, for the public lighting of Dungannon, and for private purposes, and asking us to approve of and sanction the project, do hereby accord same, believing that the adoption of the scheme will lead to considerable reduction in taxation for the lighting of the town, and will be of material advantage to private persons using artificial light not merely in the reduction of expenses, but also in the better promotion and protection of employés in factories, workshops, and shops; and we authorise all necessary consents to be given to him in furthering and promoting the undertaking, subject to the compliance with the regulations and conditions of the Board of Trade for securing the safety of the public."

Wakefield.—The minutes of the General Purposes Committee, read at the School Board meeting, contained a recommendation that Mr. Robert Hammond, consulting electrical engineer, of London, be appointed to advise the Board as to the lighting of the Ings-road School by electricity on the terms stated in his letter of December 4, 1895. Archdeacon Donne proposed and the Rev. H. G. Parrish seconded their adoption. Mr. Stephenson moved as an amendment that the minute referred to be sent back to the committee. The Chairman: For the reasons you have given in committee, I suppose? Mr. Stephenson: Yes, and some others. The mover and seconder of the resolution adopted Mr. Stephenson's proposal, and the minute was referred back. At a later stage of the meeting the following item, which appeared on the agenda, was submitted to the meeting: "To consider a recommendation from the General Purposes Committee that Mr. Robert Hammond be appointed to advise the Board as to the lighting of Ings-road School by electricity, at a fee of £5 per cent. upon the cost of the installation, with a minimum fee of 25 guineas, such fee to include drawing complete specification, adjudicating upon tenders, inspecting material supplied, inspecting work during progress, making final tests, and passing installation." Mr. Stephenson desired that this should also be referred back, and it was agreed to.

Stafford.—At the meeting of the County Council the Finance Committee reported: "That, if the cost will not exceed £200, it is desirable that electric wiring and fittings be provided for the Judges' House; that the Council be recommended to order the county treasurer to provide sums not exceeding £900 (according to estimate of county surveyor) for electric wiring and fittings, and for painting and papering and repairs throughout the Judges' House, and for necessary renewals of and additions to the furniture and household effects therein; that the Finance Sub-Committee be empowered to agree with the Stafford Corporation upon the basis and rate of charges for electric lighting; and that Mr. Bagnall be added to the sub-committee for that purpose, and that Mr. A. S. Bolton be requested to assist the sub-committee in considering the matter." Alderman W. H. Peach, in moving the adoption of the report, said that with regard to the electric light, he was glad to be able to say all the consumers were perfectly satisfied with the light and the charges which had been made for the current. The accounts sent out for the 11 weeks during which the current had been supplied amounted to about £250. It was now confidently anticipated that the concern would be able to pay its way, and not be a charge on the rates. He believed that theirs had been an unique electrical experience in that since the current had been turned on they had never had any hitch whatever.

Eccles.—The report of the Electric Lighting Committee presented at the Town Council meeting contained the following passage: "That the Council be recommended to defer the acceptance of any tender for the carrying out of the electric lighting works until after a Local Government Board enquiry has been held, and that to bring about such an enquiry the Council be recommended to make application to the Local Government Board for power to borrow the sum of £20,000 for the purpose of carrying out a scheme of electric lighting in the borough. The committee felt that by adopting this course the Council would at no further expense to the borough be able to ascertain what weight of opposition there is (if any) to the scheme after the issue of the electric light pamphlet, and also would be given this further advantage, that if it should be found in consequence of the opposition the Local Government Board decline to sanction the borrowing, the Board of Trade might with some reasonableness be asked to extend the Eccles order until such time as the Local Government Board put the Council in a position to proceed. If, on the other hand the borrowing powers were granted, the Council could then before expending any money reconsider the whole position, and take such course as they might deem advisable in the light of the information obtained at the enquiry." Alderman Kendal moved the adoption of the committee's recommendations which were as follow: "(*a*) That the electric lighting be proceeded with; (*b*) that a tender be accepted subject to borrowing powers being obtained; (*c*) that application be made for borrowing powers." The report was adopted.

Plymouth.—The Borough Council is considering whether it is advisable to supply electricity for lighting and for tramway traction; and whether, in connection with the central supply station, a refuse destructor can be advantageously used for raising steam. Mr. W. H. Preece, C.E., who has been consulted with reference to the proposed destructor, says that, although he has had no practical experience of a destructor, he has, on consideration, arrived at the conclusion that it may act as a steam raiser, and will certainly act as a feed-water heater. On economical grounds he fully supports the principle of combining the destructor with the generating station. Dr. Fleming, the expert whom the Corporation consulted, has considerable doubts as to the utility of the destructor as part of an electric lighting scheme, and advised the Corporation to make the electric lighting station at first entirely independent of the destructor. With reference to electric traction for tramways, Mr. Preece says there can be no question of its practicability, "neither can there be any question of its economy if the energy can be supplied in the power-house at 1½d. per unit delivered." The proviso is not unimportant. One unit of electric current represents, says Mr. Preece, just the power required to propel a car at the maximum speed allowed for one mile Dr. Fleming says that the average working cost of electric tramways is about 5½d. per car mile, as against 10d. for horse traction. At the Council meeting it was reported that in the minutes of the Municipal Offices Committee was a list of duties and terms of appointment relating to the office of electrical engineer to the Corporation, which stipulated the salary to commence at £300, to rise to £400.

Aberdeen.—The Gas and Electric Lighting Committee have reported to the Town Council that the gas treasurer had submitted to them a statement of the income and expenditure in connection with the electric lighting undertaking for the year ending December 31 last, from which it appeared that the balance, being profit for the year, amounted to £435. 0s. 9d. The committee recommend that this balance should be carried to and form the nucleus of a reserve fund; that the price of current for the present year be reduced and fixed at 5d. per Board of Trade unit; that the charge for meter rents be reduced and fixed as follows—viz., 12 amperes, 2s 6d; 25 amperes, 3s; 50 amperes, 3s. 9d.; 100 amperes, 5s.; 200 amperes 7s. 6d; 500 amperes, 15s. per quarter; and that the reduction on the price of current should not apply to public lighting or motors. Mr. Brown, manager of the Aberdeen district, has stated that during last year 173 new telephone lines were opened. The calls made by subscribers numbered 48,814 per week, or an average of eight calls per subscriber per day. The total length of the wires is 999 miles, there are 1,350 instruments, and the exchange lines are 100. A new switchboard, which will greatly facilitate the speed with which the wires can be connected, had been introduced, at a cost of £1,300. Aberdeen centre had been one of the most prosperous in the country. The Docks and Pilotage Sub-Committee of the Harbour Board have considered the remit as to the provision of an electric light installation for the quays. After discussion, it was resolved to request Mr. Nicol, harbour engineer, to make enquiry and report concerning harbour trusts in the south who have installations of their own, and the arrangements under which these are conducted.

Brighton.—The erection of the standards and the other necessary work in connection with the electric lighting of the streets in accordance with instructions already given by the Town Council is proceeding steadily. The original recommendation of the committee was for the erection of 120 arc lamps for the illumination of the Queen's-road, West-street, North-street, Western-road, St. James's street, Marine parade, the Steine valley, taking the route north by the London-road, and of these 80 are already in use, and it is expected that all will be complete by the end of the month. Since that recommendation was agreed to, however, the scheme has been greatly extended to take in New-road, Church-street, the Grand-parade, the east side of St. Peter's enclosure, Regency-square, and other thoroughfares, all to be lighted on the arc system, bringing the total of arc lamps to be erected up to 265; and, in addition, subject to the result of a Local Government Board enquiry, which has yet to be held, the Council have issued instructions for all streets in which the electricity mains are laid to be lighted on the incandescent system as in St. James's-avenue. These recommendations provide for the lighting of 20 miles of streets, and it is contemplated to make a

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further extension so as to include Lewes road, Bristol-road, and St. George's-road, the only omnibus routes not at present taken in hand. The undertaking has by no means reached the limit of the local resources. As many as 29 new applications were received in January, as against 18 in the previous January; 12 in January, 1894; and five in January, 1893.

St. Pancras (London).—The Electricity Committee of the St. Pancras Vestry having advertised for tenders for wiring the vestry hall and offices, reported recommending that the Vestry should accept the tender of Messrs. Laing, Wharton, and Down, of 17, Gracechurch-street, E.C., for £304. 6s. 6d. A discussion, however, ensued, which showed that the Vestry had had no instructions to advertise for tenders, and it was ultimately decided to refer the matter back to the committee for consideration and report, "as the expenditure involved was very heavy." The Vestry have agreed to regulations for the information of electrical contractors carrying out work within the Vestry's area. These regulations—consisting of 48 items—include one framed in view of the late explosions, which prescribes that "no metal framework of any fittings shall be used as part of the electric circuit, or be in contact therewith, and no connection with gas or water pipes or 'earth' allowed." It is further stipulated that "combination gas and electricity fittings must not be employed, except by the special consent of the engineer, and under such precautions and conditions as he may direct." The Vestry undertake to inspect and test completed wirings free of charge, but all subsequent tests, if necessary must be paid for at 10s. each. "Should the insulation at any time fall below the standard specified, the Vestry may, after due notice, discontinue the supply of electricity to the premises." Storage batteries can only be constructed with the sanction of the engineer. The Vestry do not undertake any responsibility for the proper execution of any work on consumers' premises, nor for any loss or damage which may be occasioned by fire, or any accident arising from the wires, fittings, or other apparatus within the buildings.

Bangor (North Wales).—At a meeting of the Town Council, it was reported that the engineer (Mr. Medhurst) had submitted drawings of a central station, etc., to the Electric Light Committee. These had been referred to a sub-committee, consisting of the chairman (Dr. H. Grey Edwards) and Messrs. P. S. Gregory and Richard Davies. Dr. Grey Edwards wished to draw attention to some interesting facts. The returns for 1895 were beginning to come in, and so far they were very satisfactory. In Aberdeen, where the electric light had been in operation for the second year, the capital had been increased by £9,800. The number of lamps had been increased from 9,067 to 16,091. A profit of £435 remained towards the reduction of the rates. The price of consumption was 2·36d., while the price obtained was 5·99d. In Leeds, where the light had also been in operation for the second year, the capital had been increased by £20,000. The lamps had increased in number from 21,720 to 32,539. Five per cent. had been distributed and £3.300 had been placed to the reserve fund which was equal to another 5 per cent. on the capital. The price of consumption at the latter town was 2·05d., and the price obtained 4·91d. He regretted that a memorial had been sent from Bangor to the Board of Trade protesting against the introduction of the electric light. He failed to see the object of the memorial; it would certainly increase the expense of obtaining a provisional order. Mr. Thomas Lewis explained that it was the unanimous wish of the ratepayers at more than one meeting that a number of gentlemen should take steps in the matter. He and others considered they had done quite right by taking the course they had, because they felt strongly upon the matter, and no doubt those who held opposite views felt equally as strong. Dr. Langford Jones pointed out that there were 13 elected councillors in favour of the electric light and only four against it.

Halifax.—A special meeting of the Town Council has been held to consider the tramways question. Alderman Booth submitted the following resolution: "That this Council do assent to the promotion of the Halifax and District Tramways Bill, subject to the terms and conditions contained in a letter dated January 31, 1896, received by the town clerk's parliamentary agents from the parliamentary agent of the promoters, being embodied in an agreement to be scheduled to the Bill, such agreement to contain clauses as to the supply of electricity by the Corporation, and to the substitution of wood pavement for stone setts, if thought necessary, by the Corporation; and that the Tramways Committee be empowered to do what is necessary to carry out this resolution." The electrical engineer (Mr. Wilmshurst) told him, with regard to the working of tramways, that there was power sufficient at his works both to light the town and work the trams, and, should this consummation come to pass, the cost of electric light to burgesses might be less, simply because the machinery would be kept working night and day. This would undoubtedly tend to an increase in the use of electricity for lighting purposes. Councillor Baldwin seconded the resolution. Councillor Whitley moved, as an amendment, "That in the opinion of this Council it is not expedient to assent to the promotion of the present Bill, but that steps should be taken to consult with other boroughs with a view to joint action in obtaining powers to work tramways." The amendment was seconded by Alderman Gaukroger. Councillor Simpson, in supporting the amendment remarked that the overhead wire system looked like so many lines hung out to dry clothes on, and especially would this be the case in Halifax. He considered that the system they would have to look for would be the self-contained cars. They could not, he agreed with the Mayor, keep deferring this question of tramways for Halifax. With such developments, however, as seemed probable in the immediate future, he felt that they would be showing a wise discretion in withholding their hands, and seeing what the immediate future would bring to bear. The amendment was carried by a large majority.

Belfast.—Mr. Norton has delivered the tenth lecture of the electricity course in connection with the university extension. In introducing the subject of motors, he said the germ of the motor was to be found in the force exerted by an electric current on a magnetic pole, which implied also an opposite force on the wire carrying the current. Devices were shown by which this force was made to cause a continuous motion. The next type of machine depended on the successive attractions of an electromagnet on iron armatures fixed on the circumference of a wheel. This was the principle of Froment's early form of motor. An electric tramway acting on this plan was shown. The modern motor is simply a dynamo worked backward, turning energy of current into mechanical energy, instead of *vice versâ*. The actions of the different forms of dynamo when so used were explained, and specimens shown, including an electric tramcar model. The relation between the efficiency of the motor and the "back E.M.F." generated in the motor was explained. The lecturer then proceeded to sketch the modern development of alternate-current motors, showing an example of a "three-phase" asynchronous motor. The lecture concluded with an account of the electrical transmission of power, and the use of transformers in this connection. The report of the Belfast Street Tramways Company for the last half of 1895 states that the question of electric traction had not escaped the attention of the directors, and they consider the time has arrived for its application to Belfast, and with this view they have introduced a Bill into Parliament for the necessary powers to be granted to this company. The directors trust that they will be able to come to an equitable agreement with the Corporation, in the interests of the company as well as the city. Should they, unfortunately, not be able to come to any such agreement, they will have no alternative but to drop the Bill, as the directors are determined not to spend any of the shareholders' money in unnecessary parliamentary litigation.

Waterloo-with-Seaforth (Liverpool).—At the meeting of the Urban Council, Mr. Killey moved, "That the agreement with the Liverpool and District Lighting Company, Limited, now produced, embodying the terms under which the Council are prepared to give their consent to the application of the company for a provisional order, already deposited by them for supply of electricity in the district of the Council be approved and the seal of the Council affixed thereto." He said they had been able to get the maximum price proposed by the order reduced from 1s. per unit to 9d. They had also got several streets added to the limit of the number in which the company proposed to lay service mains. In addition the following clause had been inserted in the order—namely: "If the local authority shall receive from any one or more of the owners or occupiers of premises situate in any of the streets following—namely, Claremont-road, Seaforth-road, and that part of Sandy-road which lies between Claremont-road and Seaforth-road, a demand in writing for a supply of energy in such premises equivalent in the aggregate to seven units per hour the undertakers shall, without requiring any such guarantee as is mentioned in Clause 23 hereof, upon receiving a notice in writing from the local authority requiring them so to do and within such reasonable time as the local authority may in each case specify, lay down suitable and sufficient mains for the purpose of general supply throughout every part of the said streets at which a supply is from time to time required by any owner or occupier of premises situate in any of the said streets, and thereafter maintain the same." The order provided for the revision of the scale of prices every seven years, which the committee had managed to get reduced to three years. Then, under the order there was no restriction as to the locality of the generating station, but it was now agreed that no generating station should be erected or existing building utilised for that purpose without the approval of the Parliamentary Committee of the Council to the proposed site. With regard to the charges Mr. Killey stated that under the agreement the charge for the supply of electricity for public lamps or for public purposes was not to exceed two-thirds of the price for the time being charged to private consumers. After the committee had obtained those terms they felt that they could not withhold their opposition to the Bill. Mr. Colton seconded the motion, and it was carried.

London Lighting Extensions.—The Highways Committee of the London County Council recommend that sanction be given to the following: A notice dated January 22, 1896, from the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, of intention to lay mains in Christchurch-road (north side), Roupel-road, Palace-road (north side), Leigham-avenue (south side), and Leigham Court-road, and to construct four large transformer boxes in the last-named road; a notice dated February 4, 1896, from the same company and under the same order, of intention to construct 38 large transformer boxes in the Wandsworth district; notice, dated January 24, 1896, from the Kensington and Knightsbridge Electric Lighting Company of intention to lay mains and to construct street boxes in Michael's-grove. The undermentioned notices from the Vestry of Hampstead had been given in accordance with the provisions of the Hampstead Electric Lighting Order, 1892: (*a*) January 27, 1896 of intention to lay mains and construct a sub-station in Compayne gardens; (*b*) February 3, 1896, of intention to lay mains in Cleve-road (south side) and High-road, Kilburn; (*c*) February 5, 1896, of intention to lay mains in Goldhurst-terrace, Redington road (south side), Greencroft-gardens (north side), and the south side of Carfield-gardens. The Vestry is the undertaker under the order, and the Council had no power of approval or disapproval of these works. The Vestry of St. Pancras had given three notices, dated

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respectively January 28 and 30 and February 3, 1896, of intention to lay mains (*a*) in Ossulton-street, and in and across Euston-road; (*b*) in Albert-road; (*c*) along and across Gower-street, and in part of Euston-road, in Lidlington-place, Houghton-place, part of two sides of Ampthill square, one side of Oakley-square, and across Eversholt-street. The mains to be laid in Gower-street are to consist of copper strip, and it was desirable that every possible precaution should be taken to prevent the accumulation of gas in the culvert. The committee recommended that the sanction of the Council be given to the works referred to upon certain precautions being taken. Sanction was also recommended to be given to the Westminster Electric Supply Corporation to lay mains across Vauxhall Bridge road, in and across Douglas-road, along Chapter street, in and across Moreton-street, and in Tachbrook-street. The committee recommended sanction to be given to the House-to-House Electric Light Supply Company to lay high-tension mains in Courtfield gardens and high and low tension mains in Collingham-gardens, and also to construct two small transformer boxes.

Leeds.—At a meeting of the City Council an important decision was taken with regard to the question of tramway traction. Mr. Hannam moved the adoption of the minutes of the Highways Committee, which included approval of the report of Dr Hopkinson recommending the trial of the Westinghouse conduit system of electric traction in a portion of Boar-lane. Mr. Hannam said that the majority of the members of the Highways Committee had been to London and seen a model at work on this system. To its working two objections were raised by the committee. They regarded the studs, which would rise from ½in. to ¾in. above the pavement, as being a source of danger to horses, as they would be very slippery. But that objection was met by the statement that the surface of the stud could be made as rough as any stone, and that there would be no more danger attaching to them than to the tramway rails. Their second objection was that the horizontal bar, or collector, might under certain circumstances become an obstruction, or be itself obstructed. Again they were assured that means could be devised whereby the bar could meet any reasonable or likely obstruction without being disconnected from the stud. Their objections on those two points having been met, the members of the committee were well satisfied with the idea of allowing an experiment with the system in Boar-lane. As to the cost, they had obtained an estimate for laying down the conduit system for a distance of 350 yards That estimate was £1,389, or about £4 per yard, as against £1. 5s. per yard on the overhead wire system. The Westinghouse Company would undertake to put this system down for £1 389, and after completing it they would allow the experiment to be continued for six months, and if it were then found unsuitable they would remove the conduits without the cost of a penny to the Corporation. Mr. Henry seconded the resolution. He said practically the Council was unanimous in favouring the adoption of electricity from Roundhay Park to Kirkstall, and if they adopted the Westinghouse conduit system in Boar-lane they would have at work three methods—viz, overhead side wires from the park to Roundhay-road end, the centre-pole system from that point to Boar-lane, and then the conduit system, with a reversion to the centre or side poles on to Kirkstall. Experimenting thus by three methods, they would in the course of a few months have evidence as to which was the best Mr. Willey moved as an amendment that the minutes of the committee be confirmed, with the exception of those relating to Dr. Hopkinson's report, which resolutions should be referred back to the committee. Alderman Baker seconded the amendment, remarking that everybody who had travelled on the Roundhay line heartily approved of it. Mr. C. H. Wilson proposed as a further amendment that the whole of the proceedings of the committee be referred back for further consideration. He explained that he was in favour of a uniform system of traction throughout the whole of the town from one end to the other. On the suggestion of the Mayor, Mr. Hannam undertook that the committee would consider the question of a uniform system throughout, and would at the next meeting of the Council be prepared with a recommendation, and thereupon Mr. Wilson withdrew his amendment. Mr. Willey's amendment was then put as the substantive motion, and was adopted.

Swansea.—The Corporation have decided to adopt a triple electric scheme of dust destruction, electric lighting, and tramcar propulsion. It was decided, before the work was begun, to take the opinion of Mr. Preece, C.B., and he has reported as follows: "I have carefully considered all that has been said against the proposals of the Town Council, but I have come to the conclusion that the Corporation would be quite safe in adopting Mr. Manville's several recommendations on their own individual intrinsic merits. Each part of the so-called triple scheme is practical and promising. They mutually support each other for the benefit of the ratepayers. The price charged for the light could be reduced to a figure below that of any other town in the United Kingdom. The demand for the light must consequently increase, and the number of lamps fixed would soon exceed the comparatively small number proposed to be installed by the Town Council. Swansea would become a pioneer town. Its inhabitants would benefit by having better transit, purer air, and cheaper light. Its finances would be improved by the profits that would arise from the successful administration of those purely local and municipal industries which the Legislature has decreed should be in the hands or under the control of the ratepayers themselves." A hitch has occurred in the negotiations for the purchase of the tramways. In consequence of the failure of the company to sign the contract of sale which had been prepared, a meeting of the Electric Lighting, etc., Committee of the Council was held on Monday afternoon. Subsequently the following report was officially supplied to the Press: "The Bill now before Parliament for the purchase of the tramways by the Corporation was considered, when it was pointed out by the chairman that an attempt was now being made by the company to depart from the terms originally proposed by the Corporation and accepted by the company. It was explained by the chairman that the amount proposed to be paid to the company—viz., £32 000—was intended to be employed as follows—*i.e.*, £10,400 to enable the company to discharge their existing mortgage debt, and the balance to be expended by the company in the purchase of motor cars for the working of the tramway system. The company, however, now required the Corporation to pay them the sum of £32,000 without the imposition of any restrictions. The committee, after full consideration, arrived at the conclusion that they could not depart from the terms originally proposed and accepted by the company. The several other modifications now asked by the company were considered, and the committee decided to agree to recommend the Corporation that as regards (1) the widening of streets necessary for the tramway service, the repayment by the company be fixed upon a 30 years' basis; (2) the Corporation agree to pay the cost of the accumulators provided the company pay for the transformers upon a 21 years' basis; (3) that the costs of the Bill be spread over a period of 30 years, the company contributing during the tenure of their lease—viz, 21 years; (4) the Corporation adhere to the provisions in the Bill as regards the Mumbles Railway service, it being understood that the Mumbles Railway Company are prepared to agree thereto; (5) the Corporation agree to purchase the plant at the end of the term—viz., 21 years—at a valuation, provided the plant is kept in proper repair to the satisfaction of the borough surveyor; (6) the efficiency or otherwise of the tramway service at any time to be a matter to be controlled by the Board of Trade." The town clerk was instructed to at once convey these terms to the company, and in the event of their non-acceptance he was directed to withdraw the Bill. A special meeting of the Town Council is to be held to day (Friday).

Dundee—At a meeting of the Gas Committee of the Town Council, the following report from Mr. Walter Brownlee, the engineer, with reference to the recent accident at the electric station was submitted: "I beg to report to you that on Tuesday, 21st ult., two accidents occurred at the electric lighting station here, whereby the supply of electricity to the city was suspended for five hours. About 10 a.m., or four hours after the pump engine had been started, the steam-pipe supplying the steam to this engine burst at the neck of the flange which is bolted to the steam chest, thus rendering the engine useless. This pipe was immediately removed and sent to Messrs. James Carmichael and Co. in order to have a new one made. Meanwhile the injector in the boiler-house was used for feeding the boilers, and was so used satisfactorily until 5.45 p.m., when the plug of the overflow valve gave way, rendering the further supply of water to the boilers impossible. With the assistance of the battery the city supply was kept up for about half an hour, when the water in the boilers had fallen to as low a level as was consistent with safety, and the fires had to be drawn, the supply of electrical energy being then discontinued. Every effort was made to get the necessary repairs effected as soon as possible, with the result that the injector was got into working order about 11 p.m, and the supply of electricity resumed at 11.15. The repairs to the pump engine were completed at 5 o'clock the following morning. The Board of Trade surveyor investigated the cause of the accident on 23rd and 24th ult., but up to the time of writing I have not received his report. In view of lessening the chance of a similar occurrence I would suggest the advisability of adding a third means of feeding the boilers, preferably by means of an electrically-driven pump. This could be driven by the current from the battery, and would thus be independent of the steam pressure at the time. Since the accident I have, as instructed by the convener, asked Messrs. Carmichael and Co. to put in a copper bend in place of the one which burst, as well as a copper pipe in place of the present duplicate steam feed-pipe, which is made of iron.' Messrs. Carmichael suggested certain improvements, and reported in regard to the injector, which is meant as a stand-by for any emergency, that they did not approve of it. They did not know any form of injector which could be relied on for this work, and advised in its place a combined steam-engine and pump of the Worthington type, suitable for feeding boilers at 160lb. pressure. It was stated that the improvements suggested by the Messrs. Carmichael had been duly carried out. The committee approved of what had been done, and saw no cause to blame anyone, being of opinion that what had occurred was an accident. They resolved to provide a new engine and steam-pump combined as an additional stand-by. At the same meeting the question of Dr. Hopkinson's patent for his three-wire system of electric lighting was under consideration. It appeared that the patent expires on July 27 next, and that Dundee, like Edinburgh, Glasgow, Hull, Bradford, and other towns, held a license from Dr. Hopkinson, who had given notice of an application to the Privy Council for an extension of the patent. Glasgow, the clerk stated, had convened a meeting of parties interested to be held at Westminster on 10th current to consider the whole matter. After a good deal of discussion, it was remitted to the clerk to instruct his London agents to attend the meeting and ascertain the course to be taken and the expense of joint opposition, after which the committee will decide on the matter. In the course of further conversation, Mr. Ballingall (the convener) suggested that hereafter the burgh engineer should make the necessary openings in the streets for the laying down of pilot wires, and thus save expense. The committee agreed to instruct Mr. Mackison accordingly.

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PROVISIONAL PATENTS, 1896.

FEBRUARY 3

2419. Improvements in electric pendulum indicators. Frederick Jones, 76, Wakehurst-road, New Wandsworth, London.

2427. An improvement in apparatus for measuring electrical resistances. Ernest Howard Griffiths, 28, Southampton-buildings, Chancery lane, London.

2435. An improved dialytic process of decomposing stable salts and thereby creating electrical energy. Carl Buderus and Joseph Menz, 45, Southampton buildings, Chancery-lane, London

2437. Improved means of applying the heat of the electric arc for welding, soldering, and other purposes. Albert Hirsch, 53, Chancery-lane, London.

2447. Improvements relating to telephones. Muirhead and Co. and Francis Lauder Muirhead, 124, Chancery-lane, London.

2459. Improved apparatus for electric welding, soldering and other purposes for which intense local heat is required. Albert Hirsch, 53, Chancery-lane. London.

FEBRUARY 4.

2501. An improved system for conveying and furnishing electricity to railway cars and devices used in connection therewith. Alvaro S. Krotz, William P. Allen, and Oliver S. Kelly. 5. John Dalton-street, Manchester. (Complete specification.)

2523. An electric railway system. Augost Casazza, 321, High Holborn, London.

2545. Improvements in automatic current-regulators. Henry Harris Lake, 45 Southampton-buildings, Chancery-lane, London. (Stanley Charles Cuthbert Currie, United States.) (Complete specification.)

2570, Improvements in telephone systems. Wallace Augustus Houts, 53 Chancery-lane, London.

2581. Improvements in telephonic apparatus. Edward Wythe Smith and the New Phonopore Telephone Company, Limited, 66, College-street, Chelsea, London.

2594. An improved electrolytic process for extraction of caustic alkali and of hydrochloric acid from a chloride. Alfred Julius Boult, 323, High Holborn, London. (Fabio Villani, Italy.)

FEBRUARY 5.

2610. Improvements in the construction of dynamo-electric machines and electromotors. Edmund Scott Gustave Rees, Wolverhampton.

2665. A new non-inductive adjustable carbon resistance. Sydney Pratt Blackmore, 28, Southampton-buildings, Chancery-lane. London.

2666. An improved fluid for use in galvanic batteries and the like. John Edward Preston, 17, Harp-lane, Great Tower-street, London.

2674. Improvements relating to armatures for dynamo-electric machinery. P. R Jackson and Co., Limited, and Joseph Slater Lewis, 31, High Holborn, London

2677. The manufacture of a new or improved substance or product suitable for use as a substitute for vulcanite, hard woods, or other hard materials, or for other uses or purposes for which same may be applicable. Henry Birkbeck, 31, Southampton-buildings, Chancery-lane London. (Pieter Wichers Wierdsma and Johannes Kuipers, Holland.)

2683. Improvements in electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

FEBRUARY 6.

2707. Improvements in incandescent electric lamps, holders, and the like. Archibald John Howard, Euston Villa, Cheddon-road, Taunton (Complete specification.)

2717. Improvement in controlling switches for dynamo-electric machines. Frederick Henry Royce and Ernest Alexander Claremont, Hulme, Manchester. (Complete specification.)

2745. Improvements in apparatus for blowing organs by electric motors. Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster.

2755. Improvements in the treatment of indiarubber and indiarubber compounds or substitutes for indiarubber. John Barclay, 7, Staple-inn, London.

2767. Improvements in telephonic systems and in switching apparatus for use therein. Alfred Roeling Bennett and George John Somerville, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2772. Method and apparatus for effecting the connection in parallel of alternate-current and polyphase dynamos and motors. Siemens Bros and Co., Limited. 28, Southampton buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

2773. Improvements in and connected with portable electric lamps. Charles Nestor Gauzentes, 4, South-street, Finsbury, London.

FEBRUARY 8.

2873. Improvements in culverts for electrical conductors and means of supporting the conductors therein. Henry Lewis Doulton and Charles Edward Morriss, Lambeth Pottery, Lambeth, London.

2875. Improvements in or connected with electric incandescent lamps. Herbert Hampton Hall and William David Cheyne 57, Barton-arcade, Manchester.

2894. An improved electric alarm clock. Alfred Herbert Webb, 70, Wellington-street, Glasgow.

2909. Improvements in secondary or storage batteries. Luis Falero and Henry Lumley 78, Fleet-street, London.

2915. An improved electric gas igniting and extinguishing apparatus. Alfred Czarnikow, 31, High Holborn. London. (Complete specification.)

2923. Improvements in alternate-current dynamos. Walter Claude Johnson, Louis John Steel, and John William Ewart, 28, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1892.

785. Incandescent electric lamps. Ries. (Second edition.)

4523. Incandescent electric lamps. Ries Electric Speciality Company and others (Second edition)

1895.

1202. Telephonic apparatus. Langdon.

3087. Telephone system. Lake. (Shea and another.)

3531. Printing telegraphs. Kamm.

5236. Starting electric motors. Ravenshaw and others.

5336. Dynamo-electric machines. Blackburn and Boyden.

5521. Electric couplings. March.

8210. Magnetic needles. Gisborne.

11748. Electric bell systems. Hodgson and Edwards.

22006. Electric railway systems. Murphy and Pierce.

23658. Electric railways. Rosenholz and Poehlman.

23855. Electric switches. Edison and Swan United Electric Light Company, Limited, and Proctor.

24166. Incandescent electric lamps. Edison and Swan United Electric Light Company, Limited, and Gimingham.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅞-6½
Brush Company, Ordinary	3	1-1½
—— Non. Cum , 6 per cent. Pref.	2	1½-1¾
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5½-5¾
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7½
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	130-122
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10½-11
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2¼-2⅜
Edison and Swan United Ordinary	3	1¾-2
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	⅝-¾
—— 7 per cent. Cumulative Pref.	2	2-2½
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	⅝-¾
Fowler-Waring Cables	5	1-1¼
W. T. Henley's Telegraph Works, Ordinary	10	13½-14½
—— 7 per cent. Preference	10	16-17
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	3⅜-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge Ordinary	5	7⅜-8½
—— 6 per cent. Pref.	5	6¾-7½
Liverpool Electric Supply, Ordinary	5	7⅜-8⅜
Liverpool Overhead Railway	10	13½-13⅝
—— 5 per cent. Pref.	10	16-16½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅝-¾
Metropolitan Electric Supply	10	12-12½
—— 4½ per cent. First Mortgage Debenture Stock	100	115-118
National Telephone, Ordinary	5	6½-6⅝
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16-17
—— 5 per cent. Non. Cum. Third Pref.	5	6½-6⅝
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	8½-9
Oriental, Limited, £1 shares	1	1½-1⅝
—— £5 Shares	5	8-8½
—— £4½ shares	4½	6¾-7¼
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-106
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	9-10
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	5½-5⅝
Westminster Electric Supply, Ordinary	5	9-9¾
Yorkshire House-to-House	5	6¾-7¼

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NOTES.

New Book.—We have received from Messrs. Alabaster, Gatehouse, and Co., Paternoster-row, a copy of "Applied Magnetism: an Introduction to the Design of Electro-magnetic Apparatus," by J. A. Kingdon, B.A.

Shop Windows.—It appears that in the United States shopkeepers troubled in winter time with frosted windows have found that by thorough ventilation, by means of electric fans, this source of annoyance may be obviated. The *Electrical World* states that in some cities the electric fan is beginning to be extensively used for that purpose.

A Novel Tariff.—The *Journal Télégraphique* describes a form of telephone tariff which has been introduced in Switzerland. A system has been started under which the annual subscription is 40fr. (£1. 12s.), but all conversations are paid for at the rate of 5 centimes (½d.) each. One advantage of this system is stated to be that it gets rid of the use of the wires for merely idle conversation. It might if the subscribers were very frugal folk. But what an amount of work it must make to keep count of the half-pennies.

Telephone to Belgium.—According to the *Zeitschrift für Elektrotechnik*, the Belgian Telegraphic Administration recently made an attempt to establish submarine telephonic communication with the English coast. The line was between Veurne in West Flanders and Dover, and two wires of the Dover and Belgian telegraph cable were used. The attempt succeeded better than might be expected, and communication was clear between Dover and Veurne, but could not be prolonged to Brussels. It was, however, thought that it was only an improvement of the land lines to London and Brussels that was necessary to make direct communication practicable between those two cities.

High-Tension Illumination.—The *Chronik* of the Vienna Elektrotechnischen Verein contains notes of the work of Mr. P. Spies, of Berlin, on high-tension illumination. Tesla's work is referred to, and Mr. Spies thinks that what has been done in this direction will not end with the production of mere playthings, but that in all probability in the development of the Geissler tube will be found the "light of the future," a light without heat. In this way the parasite heat rays which in our present electric installations reduce the energy effective in giving light to from two to four per cent. of the whole, will be reduced to a minimum, and for the first time in the arts a cold body will come into use as a source of light.

Telegraphs in 1895.—The Berne *Journal Télégraphique* of January 25 says that the past year has been one of great slackness so far as concerns the development of telegraphic network. From a table given it would seem that, while the average length of submarine cable laid has been 12,151 kilometres (7,534 miles) yearly, during 1895 the only cables completed were those from Madagascar to Mozambique, and from Obock to Jibuti, the aggregate length of which probably would not exceed 620 miles. There are, however, abundance of proposed lines. As a whole, telegraphic lines show an increased length of only 3 per cent. for the year's progress, this figure not apparently including the duplication of lines. On the other hand, telephone lines have shown a steady advance.

Appointment.—Mr. William Wilson, M.A., Bristol, has been, out of 65 applicants, unanimously elected principal of the municipal technical school at Salford, at a commencing salary of £350 per year. This technical school is in course of erection by the Corporation, at an estimated cost of over £70,000. It has separate departments for the teaching of spinning, weaving, dyeing, chemistry, physics, electrical and mechanical engineering, art, cookery, dressmaking, etc. After graduating in 1887 at Aberdeen University, Mr. Wilson held several appointments in Edinburgh—acting as demonstrator and assistant professor of physics in the Heriot-Watt College—and for the last five years he has been connected with the Merchant Venturers' Technical College, Bristol, where he has held the appointment of professor of applied phyics and electrical engineering.

The Telephone Service.—The movement at Manchester in favour of the municipalisation of the telephone service has received a decided check. A town's meeting, presided over by the Lord Mayor, was held on Tuesday to consider the question, and the attendance included the leading merchants and manufacturers of the city. On a resolution, however, in favour of applying to the Post Office for the necessary powers to carry out the project being submitted, it was rejected by a very large majority. From the speech of one of the opponents of the motion, it would appear that a fear of increasing the rates was largely responsible for this result. According to a letter of Mr. Fred Scott, hon. secretary of the Municipal Telephones Association, to the *Manchester Guardian*, a large number of the telephone company's employés were present and voted at the meeting.

Indian Railways.—In reference to the electrical communication now being fitted to the carriages composing the mail trains on the South Indian railways, the *Madras Times* says that this is a most necessary precaution in view of the outrages which have been committed by *badmashes* on women travelling alone on certain portions of the line. Our contemporary, however, remarks that it is hoped that the old method of protecting the electric "stop" by a cover of glass which has to be broken to make use of the contrivance has been superseded on the South Indian Railway by some more modern and more simple invention. Some more simple arrangement might be devised for carriages reserved for ladies. A trial trip has been made between Madras and Pallavaram with carriages fitted with intercommunication, and proved a successful one, five stoppages by means of the new arrangement having been made during the run.

The United Kingdom Telephone Defence Association.—An association under this name is being formed to endeavour to promote more efficiency and economy in the existing telephone system, so that a better service and lower rates may be secured. It will also advocate legislation with a view to the extension of the use of the telephone to all classes of the community by the prevention of monopoly in telephonic supply. About 60 influential names have been secured for the general council, and the executive council consists of Prof. Silvanus P. Thompson, Mr. R. E. Crompton, Major-General Webber, Mr. A. R. Bennett, Mr. Charles R. Haig, Mr. James Swinburne, Prof. A. B. W. Kennedy, and Mr. H. H. Bridgman. The offices of the association are at 27, Chancery-lane, W.C. The aims of the association deserve all sympathy, and it is to be trusted that its efforts will be more successful than the previous attempts which have been made in the same direction.

Mining Engineers.—The general meeting of the Federated Institution of Mining Engineers was held at Sheffield on Wednesday. In the course of a paper on the "Goldfields of Matabeleland," Mr. F. Shaw referred to what might be done by the transmission of power derived from the Victoria Falls, on the Zambesi River, some 150 miles from Buluwayo. In these falls, he said, there was undoubtedly sufficient energy to run all the machinery required for the next 20 years in the numerous gold districts, and a company had already been floated to

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utilise that source of power. It will be remembered that both as to height and volume of water the Victoria Falls are among the very few waterfalls in the world that can in any way come into the same class as Niagara, so that if the enterprise referred to by Mr. Shaw is carried out, the work will be a great one. At the same meeting a paper was read by Mr. T. Scott-Anderson on "Electrical Welding." The next meeting of the institution will be held in London on June 4.

The Best Light.—A communication from Mr. Elihu Thomson on the subject of the effect, pleasing or otherwise, of various tints of light on the eye is given a prominent position in the New York *Electrical Engineer*. Most persons will agree with Mr. Thomson that the tint of sunlight is the standard to be worked up to. A believer in the doctrine of evolution must, of course, admit that the eyes of man have been developed more perfectly to use daylight than any other light. The old-time ghastliness of arc lights seen at night, which used to be talked about a great deal but which is seldom referred to now, was due to accumulated experience of the race leading to expect that every light used at night should have a red or yellow tint. This education or inherited tendency has rapidly been evolved out of existence, and even the greenish ghastliness of the Welsbach burner does not seem to be one-tenth as offensive as it was on the first advent of the burner. This may, however, be due in a measure to a change in the composition of the network rather than to education.

The Magnetic Field.—Mr. J. C. Beattie's paper on the behaviour of various alloys in a steady magnetic field has been published in the *Proceedings* of the Royal Society of Edinburgh. The variation of resistance in bismuth is known to be great, and it was found that in alloys of bismuth it was greatest in those which contained most of that element. In all cases the variation was an increase. In antimony-zinc and antimony-cadmium alloys no variation was observed. Mr. Beattie also investigated nickel, antimony, and tellurium unalloyed, and found that the decrease of resistance in a nickel plate placed perpendicular to the lines of force in a steady magnetic field, and the increase in the resistance of plates of antimony and tellurium similarly placed are proportional to the square of the magnetisation. It would appear that the direction of the transverse effect in a conductor follows the thermoelectric series, the metals from bismuth to silver giving a negative effect, while those from zinc to tellurium give a positive effect; cobalt is an exception.

Endowment of Experiment.—A Bill has been introduced into the United States Congress for the establishment, in connection with State colleges and universities endowed with the proceeds of national land grants, of experimental stations for the mechanical arts, which shall, in their relation to engineering education and scientific investigation, be analogous to the several existing State agricultural experiment stations with respect to agricultural science. To accomplish this it is only necessary to extend the provision of the Hatch Act of 1887. It is proposed that the internal organisation of such engineering experimental stations follow closely that of the official stations now to be found in every large German town in connection with its university and technical school, and especially of the mechanical testing station at Charlottenburg, Germany. It is desired that what has been done by private munificence in several of the laboratories of American technical schools should be extended and made possible by Federal aid in every land-grant college and university.

Royal Meteorological Society.—At the monthly meeting of this society, held on Wednesday evening at the Institution of Civil Engineers, Westminster, Mr. Edward Mawley, F.R.H.S., president, in the chair, the report on the phenological observations for 1895 was presented to the meeting. Mr. R. H. Scott, F.R.S., read a paper on the recent unusually high barometer readings in the British Isles, in which he stated that the daily weather chart for 6 p.m. on January 8 was the first in these islands that ever showed 31in. The station was Stornoway, and by the next morning all over the northern portions of Great Britain and Ireland the barometers were above 31in. The highest reading of all was 31·119in., photographically recorded at Glasgow at 9 a.m. on the 9th. Mr. R. Inwards, F.R.A.S., then read a paper on "Turner's Representations of Lightning," which he considered to be true to nature, and demonstrated this by placing an actual example of Turner's work side by side with a photograph of a real flash of lightning. In reference to this it may be remarked that it has long been a matter of wonder to the common man that the traditional zig-zag flash seen in most artists' work should have persisted so long. No one ever saw anything like it in nature.

The General Public.—The New York *Electrical World* appears to have a poor opinion of the attempts made at popular science by the non-technical Press of America. Our contemporary begins an article on the subject by stating blankly that "the reader who derives his information entirely from the newspaper Press is indeed fortunate if he possesses a single correct idea on electricity or its applications. It would almost appear that those who write for the general public on technical subjects possess such a supreme contempt for their audience that they consider it only worthy of being fed with the scraps contemptuously cast aside by those who know, or with speculations manifestly ridiculous to even the first-year student in electricity." When an article is ordered for a popular audience, the writer, "instead of giving the subject and the manner of presentation the careful study always necessary in order to intelligently address a lay audience, finds it much easier to collect the odds and ends of visionary speculation and present them in a picturesque garb, or to take unmature subjects and write of them as if they were actual practical accomplishments." This is, of course, very regrettable, but it is hardly fair to put all the blame on to the authors. That sort of thing is probably asked for because the public like it.

A Cable Proposal.—A recent number of *El Telegraphista Español* contains an article by Mr. Angel Guerra on the subject of a new Transatlantic cable from Spain to the West Indies. The route advocated is from Teneriffe to Puerto Rico, and thence to Cuba and Mexico. To the objection that the Spanish Exchequer is hardly at present in a position to disemburse the 20 or 30 million pesetas that the cable would cost to lay, it is suggested that a commercial company might be found willing to do the work in return for 10 or more annual payments. The Spanish cable to the Canaries appeared at one time a very difficult matter to bring about. Nevertheless, Spanish patriotism conquered the difficulties in its way, and this cable, which at the commencement maintained only an anemic existence, has now become one of the most productive of lines, bringing in more than 400,000 pesetas (£16,000) a year. It is remarked that at present the Spanish Government has to pay large sums to foreign telegraph companies, and that in particular since the Cuban insurrection commenced in March last it has cost the Spanish Government more than a million pesetas for official telegrams. On the other hand, by the payment of three times that sum annually for 10 years the Spanish Government would become the possessors of what would be "one

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of the most important telegraphic lines in the world." Whatever may be thought of the scheme of construction proposed, the desire on the part of the Spaniards for a line of their own to connect them with their West Indian colonies and the Spanish-speaking part of America is a natural one.

Chimney-Shaft Stability.—Mr. F. J. Bancroft read a paper on the "Stability of Tall Chimneys" before the Institution of Junior Engineers last Friday. Mr. Bancroft enumerated the characteristics exhibited by chimneys that had fallen. Such shafts had usually been observed to "sway" or "rock," which movement, although a source of alarm to some people, had by others been regarded as an essential condition of safety, as showing the admirable elasticity possessed by the structure; cracks had also been traceable, starting on the windward side and descending obliquely to the leeward side of the shaft, which had finally collapsed by the crushing of the material through the concentration of the pressure on one side. The author combated the idea of rocking being indicative of safety, and showed that separation must take place at the joints, while the swaying, with its concomitant pressure and relief, promoted disintegration, and caused the shaft to be still less capable of resisting the recurring wind pressure. In conclusion, attention was directed to the danger attending the practice of increasing the height of a shaft in order to obtain more draught. The velocity of gases up the chimney being proportional to the square root of the height, increased duty was better obtained by larger diameter than by greater height. It was, therefore, advisable to have ample area in designing a chimney. A discussion followed.

Accident.—An accident is reported to have taken place last week at the Southport electric lighting works at Crowlands, in which a man received a current at a pressure of 2,000 volts through unusually good contacts and still survives. According to the *Southport Guardian*, a workman named John Williams was standing against No. 2 rectifier trimming the brushes in readiness for the evening's work, and while thus engaged his right leg accidentally touched a brass screw-head in the wooden guard protecting what is known as the water switch, and some keys in his pocket serving as a conductor, the full pressure of the current—2,000 volts—passed through his body, the circuit being completed by his right hand on the top of the machine. He was at once rendered unable to move, but a fellow-workman, Robert Black, seized him by the clothes and dragged him forcibly away. The current had burned a large hole in the flesh of the leg, while on the hand some of the bones were exposed. Williams was quite unconscious, and apparently lifeless, but rubbing and other means of restoring respiration and consciousness were resorted to, and in less than 10 minutes these efforts were to a large degree successful. The injured man was removed to the infirmary, where he was detained as an in-patient, and during the day he showed a marked improvement. As to the cause of the accident, it was afterwards ascertained that the brass screw referred to just pierced the wooden guard, the point coming in contact with the metalwork of the rectifier. It was not a part of the machine, but a screw used merely for holding in position a connecting-rod, which is hung outside the guard when not in use, and nobody was aware that it touched the metalwork inside.

A Workhouse Telephone.—The telephone system which has been installed at the Birmingham workhouse infirmary at Spring Hill is claimed to be unique in regard to the variety of the communicating apparatus there concentrated on a single switchboard. A clock surmounts the structure, immediately beneath being the alarm-bells for fire and emergency. Below the bells are panels, in which the code signals are exhibited. In front is suspended the attendant's transmitter, which is of the Hunningscone type. The adjustment to any desired height is effected by a patent spring roller. On either side of the indicators and switches are panels, and on these, within easy reach of the attendant, are "plunger pushes" for the fire-alarms, bell to the nurses' home, the boiler-house, and the doctor's call-bell. The switchboard has been so designed that it can be removed from its position against the wall to allow of any alteration or repairs without interrupting the communication. This is effected by means of flexible cables between the terminal-board and the switchboard. The wires on the terminal-board are all fixed to brass plates bearing their name and number, to facilitate the testing necessary to locate a faulty line. In the old switchboard no such arrangement was made, and as a consequence the rear was a mass of tangled wires, and thus the utmost difficulty was experienced in getting at the working parts of the board, to say nothing of the liability to faults. The switchboard was designed by Messrs. Walker Bros., Birmingham. It is computed that the telephone lines within the infirmary and surrounding grounds now extend to something like 20 miles, the infirmary buildings covering an area of about 3½ acres. The recent improvements have been personally supervised by Mr. J. B. Walker, chairman of the Infirmary Management Committee, who, in common with the other members of the committee, has left nothing undone to make the arrangements as perfect as possible.

Modern Apparatus.—Mr. W. J. Buckley, in a paper read before the North-Western Electrical Association at Milwaukee, Wisconsin, gives the following table of efficiencies of 100-volt 16-c.p. lamps as the result of a test made with some of the prominent makes:

	Amperes.	Watts.	Watts per c.p.
Thomson-Houston ...	·62 ...	62 ...	3·875
Edison	·55 ...	55 ...	3·437
Buckeye	·56 ...	56 ...	3·500
Packard	·57 ...	57 ...	3·362
Bernstein	·65 ...	65 ...	4·062
Beacon	·54 ...	54 ...	3·375
American	·58 ...	58 ...	3·625
Columbia	·61 ...	61 ...	3·800
Keystone	·56 ...	56 ...	3·500

In the course of an extensive survey of the existing state of electrical practice in America, Mr. Buckley advocates direct-connected dynamos, 2½-watt lamps, large transformers, high frequency, unless the power service is more important than the lighting, in which case a low frequency should be adopted. If the power service is in small motors the system should be single phase, but if motors of more than 50 h.p. are to be driven a multiphase system is better. On this subject it is remarked: "When the purchaser comes to buy alternating apparatus he is confronted with single-phase, quarter-phase, two-phase, three-phase, multiphase, and monocyclic—surely enough to feaze him to start with. But what system will fit his conditions? Which machine should he buy? With the use of an efficient motor the single-phase is the ideal alternating-current system. No condensers, no balancing of the load, no fixed arbitrary line loss, but two wires on the line, all giving a flexibility that affords a minimum cost in power, arc and incandescent services from the same machine and circuit. All the catalogues of multiphase apparatus contain statements, variously expressed, that a single-phase synchronous motor is the most desirable but unattainable type. This is no longer true as to unattainability. Single-phase motors are now sold on the market having as high a commercial efficiency as is obtained in any but the large types. They are self-starting at full load with maximum torque. They require no special circuits or connections, no starting

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rheostat, no condenser, and no special transformer, the ordinary lighting transformer answering the purpose. Being in step with the generator, the regulation of the synchronous motor is perfect under all loads, and the motor will pull out of step and stop running if more than a 50 per cent. overload is applied."

Motorcarts.—By invitation of the vice-presidents and council of the Motorcar Club, several members of the House of Commons, and a number of social and commercial magnates, were shown on Saturday a practical display of horseless vehicles, given in the North Gallery and West Gardens of the Imperial Institute. Among those present were Prince Edward of Saxe-Weimar, Sir William Harcourt, M.P., Dr. Rentoul, M.P., Mr. Atherley-Jones, M.P., Sir Frederick Abel, Sir J. Somers Vine, Mr. Hiram Maxim, Mr. H. H. Cunynghame, Mr. H. J. Lawson, Mr. Bertram Van Praagh, Mr. Frederick R. Simms, and the Hon. Evelyn Ellis. Four cars were exhibited, three of them driven by oil motors and the fourth by electricity. This car was the work of Messrs. Garrard and Bumfield, of Coventry. All the cars were shown in operation, under the superintendence of the Hon. Evelyn Ellis and Mr. F. R. Simms, and subsequently Mr. Bertram Van Praagh, vice-president of the club, delivered an address, in which he ventured to prophesy that motorcars would before long form one of the greatest industries of the world. In reference to this subject, it is stated that the Government Bill dealing with motorcart road traffic has been prepared, and will be introduced shortly. It is based on the lines of Mr. Shaw-Lefevre's Bill of last year, but it deals with the question more broadly. It contains no provision restricting the speed at which the new vehicles may be driven, any abuse being left to be dealt with by the ordinary law against the reckless driving, so that the English law will be rendered more favourable to the new traffic than that of France. There appears at present to be no opposition to the Bill, and the members who have interested themselves in the matter believe that the result of its passing will be the immediate appearance of a number of the new vehicles on English roads. Several road authorities have during the week decided to petition in favour of the Bill. Few things are more remarkable than the complete change that has taken place in public sentiment in reference to the introduction of this kind of vehicle. It is not so very long ago since every horseowner would have been up in arms against it.

The Rontgen Radiations.—A large number of experimenters have been at work on this subject during the last fortnight, but little has been done towards coming to any definite conclusion as to the nature of the new radiations. According to the *Elektrotechnischer Anzeiger*, Mr. Alfred Wehrsen has obtained them in Berlin with the help of an influence machine, while at Renfrew, Lord Blythswood has obtained Röntgen photographs by using the brush discharge of his fine Wimshurst induction machine. It would therefore appear that a high vacuum is not an essential condition for the production of the new radiations. An important discovery of Lord Blythswood's is that the Röntgen rays are liable to something equivalent to colour absorption, for on placing strips of coloured gelatine in front of the photographic plate, the blue was least sensitive, red next, and yellow most. The connection of this fact with the colour of the light in the Crookes tube during the discharge may have an important bearing on the theory of the subject. There are on record several curious experiments in which an effect has been produced by very strong lights on a sensitised plate enclosed in a metal case. Metal dark slides being in common use, these have been hitherto generally discredited or referred to the action of the "heat rays." Several French observers now state that a photographic effect is obtained on a plate enclosed between sheets of metal not only with the electric arc, but even with a petroleum flame if the exposure is long enough. The experiments of Mr. Le Bon in this direction have been accepted by the Paris Académie des Sciences, and the phenomenon must therefore be accepted as a real one. In one case cited the image of an aluminium medal was obtained in this way after an exposure of two hours. The Académie have also received communications from Messrs. Benoist and Hurmuzescu on the action of the new rays in causing a discharge of the electroscope, and from Mr. Chabaud on the transparency of metals to them. Platinum ·01mm. thick was absolutely opaque, as was mercury in a thickness of ·1mm. Other metals were transparent in various degress. The subject was also discussed at last week's meeting of the Royal Society, when a paper by Lord Kelvin on the generation of longitudinal waves in ether was read, in which was described an arrangement for obtaining pressural disturbance through a considerable space of air, accompanied by a very small proportion of ordinary transverse waves. A paper by Prof. J. J. Thomson was also read relating to experiments, from which he concludes that all substances when transmitting the Röntgen rays are conductors of electricity. In the course of the discussion which followed Captain Abney said he ventured to doubt whether the action of the Röntgen rays on a sensitive plate could properly be described as photographic. Several facts, in his opinion, indicated some preference for the view that the Röntgen rays acted by first setting up phosphorescence or action of some unknown kind in the glass at the back of the sensitive film. A large number of experiments were also described by Prof. Dewar, showing that resistance to the passage of Röntgen rays increased with increase of atomic weight. Organic substances were all relatively transparent, following the carbon, oxygen, hydrogen, and nitrogen of which they are composed. Mere complexity of structure made no difference, but substitution products showed increasing opacity in the order of the atomic weights of the combined chlorine, bromine, and iodine. It has also been reported in the non-technical Press that M. Carmichael, of the Faculty of Sciences at Lille, has worked out a way of reflecting the new radiations from steel mirrors. He can thus, he says, use them on photographic plates set between the mirror and a Crookes tube. A clear image is thrown back by the mirror on the plate. A most remarkable report was one that Prof. Salvioni, of Perugia, had succeeded in the conversion of the Röntgen rays into visible light. Startling as this might seem, it was on the longitudinal vibration theory by no means impossible, it being one of the troubles of that theory that under certain circumstances there ought to be a conversion of a part of the vibrations from transverse to longitudinal, or *vice versâ*. A description of Prof. Salvioni's instrument has, however, appeared in a footnote of the *Proceedings* of the Vienna Elektrotechnische Verein, published in the *Zeitschrift für Elektrotechnik*, from which it appears that the essential part of the apparatus is a black paper tympanum, treated with some substance that fluoresces under the action of the Röntgen rays, and mounted in a cylinder. It is therefore merely a fluorescence effect, and not a case of direct conversion. The image is produced on the tympanum by the "shadow" from a Crookes tube at one end of the cylinder and viewed through a lens at the other. Before quitting the subject, it may be remarked that one experimenter has considered that the suggestion that the rays might be used as a germicide was worth following up. There was, of course, a negative result.

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CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXV.

(Specially Contributed.)

Wattmeters.—These are combination instruments, and before describing them it will be well to see how ammeters and voltmeters are used. Although it is usual to look upon the insertion of an ammeter into a circuit as not altering the conditions of the circuit, its use means increase of resistance, hence an alteration of condition. In practice, however, it is necessary to know the current, and so the use of instruments is an evil that cannot be remedied. To know the current effect in any circuit, the ammeter must be so placed as to indicate the total current effect of that

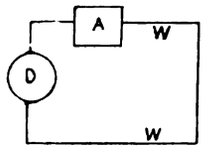

FIG. 1.

circuit. Thus (Fig. 1) the ammeter, A, indicates the total current through circuit, W W. Similarly Fig. 2, although

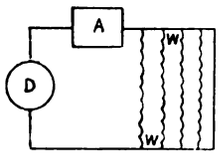

FIG. 2.

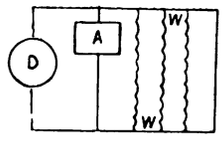

FIG. 3.

in this case the circuit comprises several branch circuits If, however, the ammeter is connected as in Fig. 3, it indicates the current in that branch circuit only, and not the total current generated by the dynamo. In all cases the ammeter is put in series with the resistances forming the other parts of the circuit. Branch or parallel resistances, as I have before explained, are equivalent to increasing the sectional area of all or part of the conductor of the circuit. This I might indicate diagrammatically by Fig. 4, which again is electrically the same

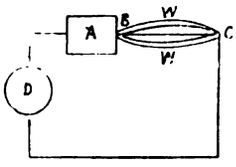

FIG. 4.

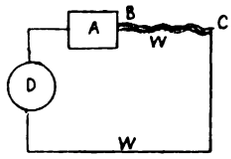

FIG. 5.

as if the conductor strands from B to C were twisted, as in Fig. 5, to form one single conductor. We do not look upon a conductor made up of a number of strands as a circuit of a number of parallel branches, yet it might be so looked upon. Once more, then, adding branch circuits is equivalent to increasing the area of a conductor, nothing more, so far as circuit resistance or total current is concerned.

The voltmeter, however, is not used like the ammeter. It is put in parallel with the conductor between the two points, the difference of potential between which is to be

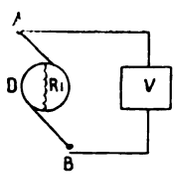

FIG. 6.

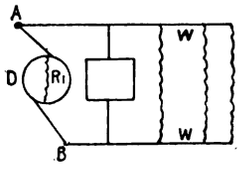

FIG. 7.

found. Thus (Fig. 6) A and B represent the terminals of a dynamo, R_1 the armature resistance of the dynamo. To get the difference of potential between A and B, we join the two points through a voltmeter. In this case there is no other external circuit, and the dynamo would be said to be on open circuit. If, however, there is an external circuit, W W, as in Fig. 7, the voltmeter is still in parallel now with both internal and external resistances.

The ammeter is placed in *series* with the other circuit resistances.

The voltmeter is placed in *parallel* with the other circuit resistances.

The ammeter measures amperes, the voltmeter measures volts, and we have seen that for steady currents the product of amperes and volts is watts. If, then, we can get an instrument indicating the product of amperes and volts, its indications will be in watts. The wattmeter is such an instrument. The consideration of the difficulties introduced by alternating currents would lead us too far afield, so we must for the present restrict our description to the instruments for steady currents. Fig. 8 combines on one diagram the method of connecting up ammeters and voltmeters. D indicates the dynamo, A the ammeter, V the voltmeter, and W W the external circuit. Recall what has been said of electro-dynamometers. If we have two conductors, A and V (Fig. 9), one at right angles to the other, the tendency of the conductors when a current goes through each is to become parallel, and the measure of this tendency is equal to the product of the two currents.

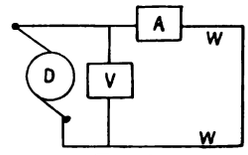

FIG. 8.

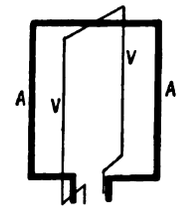

FIG. 9.

Then, if one coil is connected up as an ammeter and the other as a voltmeter, the measure of this tendency is the product of the currents in the coils; but one of these currents is the full current in amperes; the other varies as the pressure in volts, and the product—amperes and volts—will be proportional to the watts, and thus the instrument may be graduated as a wattmeter. In an instrument so arranged, one coil, or set of coils, must be of low resistance to be connected as an ammeter; the other coil, or set of coils, must be of great resistance to be connected up as a voltmeter. You will see that the difference between an electric dynamometer and a wattmeter is that in the former the same current goes through both coils, while in the latter the currents are different.

Kinds of Wattmeter.—Instruments of this kind are divided into two classes, known as *indicating* wattmeters and *integrating* wattmeters. The province of the first kind is simply to indicate the instantaneous value of the volts and amperes, while the second class do not indicate instantaneous values, but integrate the total energy delivered to the circuit during the time through which they are attached to it. Thus the readings of the latter are in watt-minutes, or watt-hours.

Thomson Wattmeter.—As an example of this class of instrument I may describe one designed by Prof. Elihu Thomson, and shown in Fig. 10. It consists of two vertical coils, which constitute the field coils of the armature shown inside. The field coils are fixed; the armature revolves. Neither field coils nor armature contain iron. The field coils we may call the ammeter part of the instrument. They are in series with the circuit, and all the current goes through these. The armature, which is of the Siemens drum type, is hollow, and is made of a fibre cylinder, over which the coils are wound. On the end of the shaft of the armature is a silver commutator, on which rest flexible bronze brushes provided with silver contact-pieces. The armature forms the pressure or voltmeter coil, and is connected in parallel. The armature resistance is high in itself, but in order to still further increase the resistance of the branch circuit a high resistance of fine wire is connected in series with it. These parts of the instrument form the wattmeter proper, but to make it a practical instrument other important details are added. An essential point is the slowing mechanism. The shaft of the pressure coil is

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carried downwards, and on it, a little distance below the coil, is fixed a copper disc. This disc rotates between the poles of three permanent magnets, which, as the disc rotates, generate eddy currents in it. Thus the reactions between the copper disc and the permanent magnets cause a drag or load on the motor, and this drag or retarding effect is directly proportionate to speed. At the top the

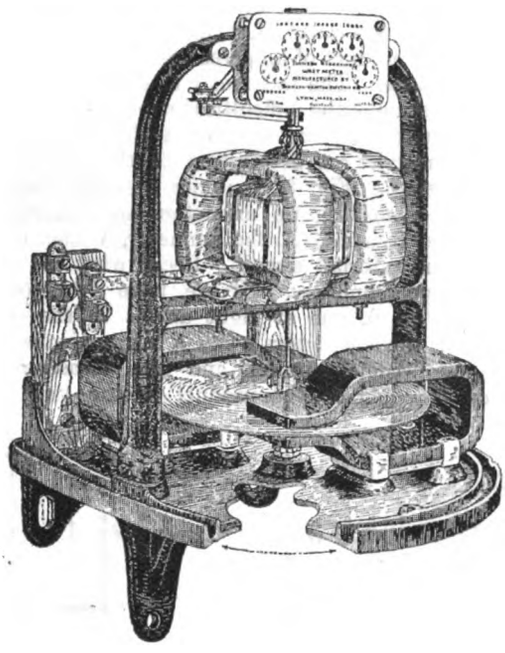

FIG. 10.

motor spindle engages a train of gears, which cause the dials to show the power consumed in the circuit in watt-hours.

THE ELECTRIC STREET RAILWAY SYSTEM OF MONTREAL, CANADA.

At the ordinary meeting of the Institution of Civil Engineers on Tuesday, the 18th inst., Sir Benjamin Baker, K.C.M.G., the president, in the chair, the paper read was on "The Electric Street Railway System of Montreal, Canada," by Mr. G. C. Cuningham, M.I.C.E.

The author traced the rapid development in Canada and the United States of the application of electricity to street railways. In the United States in 1888 there were about 20 electrical roads in operation, having a total of 80 miles of track, and working 90 motorcars, while there were now 10,363 miles of track, on which were operated over 40,000 motorcars. While this had been the progress in the United States, Canada had not been slow to adopt a system that was manifestly so convenient for the public. Montreal, Toronto, Hamilton, Ottawa, Winnipeg, Brantford, Niagara Falls, and other places had their electric systems either complete or in process of construction. Almost all the lines were constructed on the overhead trolley-wire system.

In Montreal the electric street railways comprised 74 miles of single line, laid on 41½ miles of streets. A daily service of 140 motorcars and about 50 trail cars was now running. The gradients were in many cases very severe. On the streets running at right angles to the St. Lawrence River there was a continuous rise in most instances, and short sections had gradients of 1 in 10, and even 1 in 8. These gradients were a severe test for the motorcars, but they were overcome successfully, and caused little difficulty.

The ordinary rail adopted was $6\frac{9}{16}$in. in height, and weighed 72lb. per yard. The rails were laid on a foundation of concrete, or embedded in it, according as block pavement or asphalte was used for the roads. The rails were constructed in complete electrical continuity, and where they passed the power station they were directly connected by copper wiring to the generators. Bond-wires were riveted into the web at each joint. To still further improve the return circuit, track return wires of the same size, 0·460in. in diameter, as the line feeders were riveted into the web at various points and carried back to the generators directly by overhead insulated copper wires. At first earth returns had been used, the rails being connected by copper wire to cast-iron car-wheels buried between 7ft. and 8ft. in the soil; but considerable electrolytic action was found to be set up between the earth and gas or water pipes. It was determined not to use the ground for this purpose, and to construct a complete metallic return.

The trolley wire used throughout the system was of bare copper, 0·365in. in diameter, carrying a safe current of about 440 amperes. It was suspended from poles between 110ft. and 120ft. apart at the kerb line on either side of the street, at a height of between 18ft. and 20ft. over the centre of each track. In some instances the trolley wire was carried by a central line of posts placed between the double tracks. The current had been at first supplied to the trolley wires connected in one continuous system; but this was now divided into various independent sections, so that trouble on any one was felt there only, and did not affect the others. Each section was fed directly from the power station by feed wires, and had its own system of return wires. The feed wire and return wire mostly used was 0·460in. in diameter, but within a three-quarter mile radius of the power station heavier insulated cables were inserted, about 1in. in diameter, carrying a safe current of about 600 amperes. Ten such wires led from the power station, and 10 others of same size acted as return wires, allowing for a total output from the power station of 6,000 amperes. The difference of potential maintained at the generators was 550 volts.

The boiler-house and engine-room were placed fairly centrally to the system, and near to the Lachine Canal, whence water was obtained for condensing purposes, and to the coal wharves. There were 15 Lancashire boilers, each 28ft. long by 7ft. in diameter, with double furnaces. They developed each 300 h.p., and carried a working pressure of 125lb. per square inch. The gases from the furnaces, after passing through the boiler flues, returned under the boilers and along their sides to the main flue. They then passed, at a temperature of between 439deg. F. and 480deg. F., into Green economisers placed on each side of the chimney, which heated the feed water to about 260deg. F. The temperature of the gases entering the chimney was between 225deg. F. and 250deg. F. The feed water was obtained from the condensing water, and entered the economisers at an average temperature of 90deg. F. The fuel used was bituminous coal from the Cape Breton mines, of an evaporative power of 6½lb. of water per pound of coal.

The engine and dynamo room was 235ft. long by 89ft. wide. There were six horizontal cross-compound condensing engines developing 600 h.p. each, with a boiler pressure of 125lb. per square inch. The cylinders were 24in. and 48in. in diameter, and steam-jacketed, with Corliss valves. The diameter of driving wheel was 22ft., its peripheral velocity at 70 revolutions per minute being nearly 4,900ft. per minute. The total weight of each engine was 85 tons. The engines were placed in a row next to the boiler-house, 26ft. from centre to centre, on foundations of cement concrete and brick in cement. Each of the first three engines drove four Edison generators, developing 200 kilowatts apiece. The driving wheels were double-crowned, and carried two pairs of belts, driving 41in. pulleys, fixed on the armature shaft of the generator. The three remaining engines drove each a pair of multipolar generators by one 52in. belt on one pulley, 48in. in diameter. The two generators were mounted on the same bedplate, with the pulley between them. The armature shaft and the pulley shaft were in alignment, and were connected by two friction clutches. By this means the generators could be driven together or separately. The generators were supported on a continuous length of foundation wall built in brick and cement, and sufficiently massive to be free from vibration.

The rolling-stock equipment in the summer amounted to 163 motorcars; in winter it was 145 closed cars with double motors, and 14 snow-sweepers with triple motors. There

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were besides, 53 open trail cars and 60 closed trail cars belonging to the former horse system.

The motors developed 25 h.p. or 30 h.p. each, and were all of the single-reduction type, the ratio of the pinion to the gear-wheel being generally about 4 to 1. The average speed of the cars was about 7½ miles per hour. Electric snow-sweepers, 18ft. long, carried on two pairs of 33in. wheels, were used. To each axle was geared a 30-h.p. motor, a third motor being placed in the car to drive the rotatory brooms.

The cost of working for July, 1895, was almost exactly 3¾d. per car mile, and that of the power was less than ½d. per car mile. For the year ending September, 1895, the cost was 5⅓d. per car mile, the average cost of power being slightly under ¾d. per car mile.

In an appendix particulars were given as to the amount of coal consumed and electrical energy developed at the William-street power station, with details of the operation of the system during the past four years.

THE TIME-RATE OF GROWTH OF MAGNETISATION OF IRON AND ITS IMPORTANCE TO THE ELECTRICAL ENGINEER.*

BY ERNEST WILSON.

The permanent magnet, or loadstone, has been familiar to mankind from early times, and is at the present very useful to the electrician. Volta, about a century since, marked an epoch in the science of electricity by his discovery of the cell now known as the "voltaic" cell. It consists simply of two plates, one of copper and the other of zinc, dipping into brine or dilute sulphuric acid, but not touching one another. A copper wire is soldered to each plate, and when the wires are touched together they are more or less heated; in the process, energy is transferred from the cell to the wire by the agency of what we call the electric current. Many different forms of primary battery have been devised since Volta's time, not to mention the storage cell.

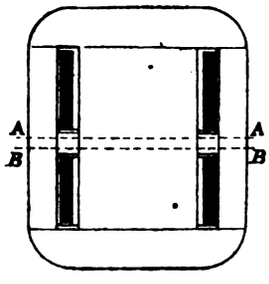

FIG. 1.

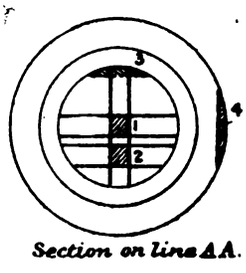

FIG. 2.

Soon after Oersted's discovery of the action of the electric current upon permanent magnets, Arago and Davy independently discovered how to magnetise iron by causing an electric current to circulate round an iron bar in spiral coils of insulated wire wound on the bar. If the iron be very soft—wrought iron, for instance—it will only be strongly magnetised when the current passes, and such an arrangement is known as an "electromagnet"—a name due to Sturgeon, who early constructed powerful electromagnets. The electromagnet is familiar to almost everybody nowadays. One meets with it in electric bells, telephones, dynamo-electric machines, arc lamps, and in a variety of other cases.

It is not necessary to dwell long upon the discoveries of Faraday in electromagnetism, which are the foundation of the modern dynamo—a machine which enables us to dispense with batteries for the purpose of producing electric currents, and converts mechanical energy directly into electrical energy. But I particularly wish you to note that in 1831 Faraday discovered that electric currents can be induced in a closed circuit—a copper wire, for instance, joined on itself—by moving magnets near it, or, what comes to the same thing, by changing the magnetism within it.

Let us return to our electromagnet. We have seen that when an electric current is passed through the copper wire wound on the magnet, the iron becomes magnetised, and is capable of exhibiting the same properties as permanent magnets. We have here on the table an electromagnet of ordinary form, with an iron core 4in. diameter.†

Downstairs in the engine-room there is another of different construction, having a core 12in. diameter. This larger magnet is shown in Figs. 1 and 2.* It consists of the central core, which has the copper coils wound on it for the purpose of magnetising it, and to complete the magnetic circuit a slab of iron, top and bottom, and a ring of iron concentric with the core.

Suppose, now, that either of these magnets is magnetised by passing an electric current through the copper coils wound on them, and that by means of a reversing switch we suddenly change over the direction of the current in the coil and have sufficient battery power to compel it to speedily attain a steady value, equal and opposite to that which it had before reversal took place. Fig. 3 shows the arrangement of apparatus by means of which this can be accomplished.

If the core be solid, as is the case in our magnets, what we find is, that on reversal of current the magnetism of the interior of the core becomes reversed in direction, but at a later time than the magnetism near the surface; and that this time, other things being equal, is greater in the 12in. magnet than in the 4in. magnet. In order to demonstrate this time effect to you we have bedded near the centre of each core a small exploring coil which is connected to a D'Arsonval galvanometer. Also near or on the surface of each magnet we have another coil connected to another D'Arsonval galvanometer. These instruments are made by Mr. R. W. Paul, Hatton-garden, London.

The bedding of these coils is a little differently carried out in the two cases. In the 12in. magnet, holes are drilled through the core in a plane at right angles to its axis midway between its ends, and by means of hooks insulated wires are threaded through these holes so as to enclose a small sample area at the centre; the outer coil in this case only encloses a sample area near the surface. This is shown in Fig. 2; the respective areas are numbered 1 and 3.

In the 4in. magnet on the table the central coil surrounds a rod of the iron, which, after being wound with the coil, was

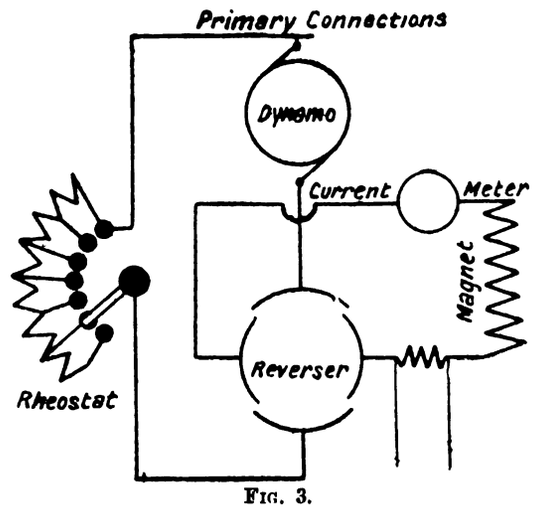

FIG. 3.

forced into a tube of the iron by means of hydraulic pressure, the ends of the coil being brought out to terminals at each end. The coil on the surface is simply wound round the magnet.

We have said that a D'Arsonval galvanometer completes the circuit of each exploring coil, and the deflection of the spot of light reflected from the mirror of the instrument tells us what is going on within the particular coil—that is to say, if we change the magnetism within the coil we shall induce, as Faraday found, an electric current in the circuit of the coil and galvanometer which deflects the needle; so that when the deflection is great we know that the time-rate of change of magnetism within the coil is also relatively great. These D'Arsonval galvanometers act, then, as a kind of eye-piece, by means of which we can see what is going on at the centre of the core and at the surface of the core at any time.

Let us take the 4in. magnet first. You note there are three spots of light on the screen. The top spot tells us what is going on in the innermost coil; the intermediate spot tells us about the outer coil near the surface of the core; and the bottom spot is in connection with the current which magnetises the magnet. What we shall note is this: When the reversal of current takes place, the bottom and intermediate spots will be immediately deflected, showing that the current is almost immediately totally reversed, and the change of magnetism occurs at once in the outermost coil. After a lapse of time the top spot begins to move, and shows by its maximum elongation when the rate of change in magnetism is a maximum for the innermost coil.

The same remarks refer to the large magnet, but we shall find that the time between reversal of current and when the

* A lecture delivered before the Engineering Society, King's College, London, February 14, 1896.

† See *Phil. Trans.*, Royal Society, vol. clxxxvi., 1895.

* See *Journal* of the Proceedings of the Institution, of Electrical Engineers, part 116, vol. xxiv.; Royal Institution, April 26, 1895; also *Electrical Engineer*, May 3, 1895.

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innermost coil experiences its maximum rate of change is smaller in the case of the 4in. magnet than in the 12in. magnet, the ratio being about 1 : 9. We shall further note that if the reversals are slowly and continuously performed, the innermost coil is not seriously disturbed, owing, as we shall presently see, to the shielding action of induced electric currents rendering the interior of the core practically useless for the purpose of magnetic change.

These time effects can also be shown by curves which have been recorded by means of photography on a plate moving at an appropriate speed before the spot of light. In Fig. 4 are two curves obtained from the innermost coil in the case of the two magnets—No. 1 in the 4in. and No. 2 in the 12in. Horizontally we have time in seconds ; vertically, the deflection of the instrument. These represent graphically what we have seen on the screen. The maxima occur at 6 and 59 seconds, the magnetising forces (H) being 11 and 16 respectively. The apparatus for recording these curves is on the table, but I do not wish to take up time on its explanation. It was made by Mr. W. Groves, Bolsover-street, London.

We have next to consider the cause of this marked effect and how it depends upon the magnets used. Roughly stated, the reason is that the iron of the core itself is a fairly good conductor of electricity, and it is solid: therefore, when the changes in magnetism begin on the outside of the core, they immediately set up opposing electric currents in the iron of the core itself, just as Faraday showed 65 years ago, only that iron is the conductor instead of copper. These currents, as they die out, on account of the magnetism being established in its reversed direction, allow a further penetration of magnetisation. This goes on from point to point until the centre is reached, and the reversed magnetism is fully established over the whole of the core. Now, the time taken to accomplish this process of reversal is intimately connected for a given magnet with the

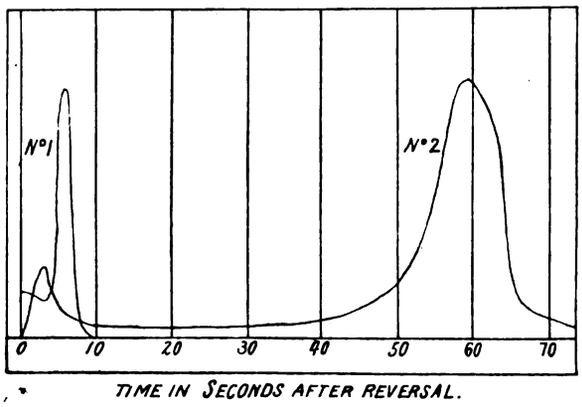

FIG. 4.

curve of magnetisation of the material, and it is not my intention to enter into a full explanation. But this is certain, and the experiments just made have fairly well shown it to be, so that if we compare two magnets similar in every respect then, if the external magnetising forces are the same in the two, similar magnetic events will happen, but at times after reversal varying as the square of their linear dimensions—that is, in our 12in. magnet the times are nine times those in our 4in. magnet. We infer from this that if we go on reducing the diameter of the bar we can make the times as short as we please—that is to say, if our 12in. core were not solid, but composed of a number of small cylinders or wires insulated from one another, and each 1-25th part of an inch diameter, everything would happen exactly as we have seen, but 90,000 times as quickly. If a non-conductor of electricity having the magnetic properties of iron could be found, there would be no necessity for subdivision in order to prevent induced currents.

I now come to the importance of this time-rate of change of magnetisation to the electrical engineer. Suppose, for a moment, that we could not prevent these induced electric currents in the iron of our core. This would mean that all direct-current dynamos and alternate-current transformers would be rendered useless, and we should be thrown back upon alternate-current machines without iron in the armature, and have to use rectifiers for direct or intermittent currents.

The fact is, that when we reverse our magnetising current, and eventually the magnetism of the whole core, work is done upon the magnet by the magnetising current other than that required to heat the copper coils. If we subdivide the core to such an extent as to practically annul the induced electric currents about which we have been speaking, there would still be a dissipation of energy in the core due to what is known as magnetic hysteresis ; but if the core be solid, the induced currents become a very serious matter, and represent energy which is dissipated and goes to heat the core. We have here a solid ring of soft iron—that is, it is not subdivided so as to stop electric currents induced within it, and at present it is quite cool. We now pass an alternating current round the magnetising coils wound on it so as to reverse the magnetism of the iron about 50 times per second. We find that it speedily becomes heated, partly owing to magnetic hysteresis, it is true, but almost wholly from induced currents. If it had consisted of a bundle of iron wires, the heating would have been in the same time almost imperceptible. It is fortunate for electrical engineers that by subdivision of iron in the form of thin wires or plates, the induced current can be kept at such a magnitude that its heating effect in dynamo-electric machinery is not more troublesome than the unavoidable heating due to magnetic hysteresis, which is a property peculiar to the material, and cannot be suppressed.

In addition to this dissipation of energy we have the shielding action of these induced currents, which renders the centre of solid iron cores or wires practically useless for the purpose of change of magnetism in the case of alternating currents of sufficiently high frequency. Take the 4in. magnet on the table. If we pass an alternating current through its magnetising coils having a frequency of 1/20—that is, the current is alternately positive and negative, and makes a complete reversal in 10 seconds—only the outside portion of the core is really useful, the centre being screened by the induced currents. With this frequency, a tube would be practically as useful as the solid core, the external diameter being the same. This is the same thing as stating that in the case of a soft iron wire one millimetre in diameter only the outside layers are really useful if the frequency be 500.

In conclusion, I wish to express my thanks to Dr. Hopkinson for allowing me to use his large magnet downstairs. In fact, the whole of this apparatus is the same as was used by him before the Royal Society, Royal Institution, and Institution of Electrical Engineers. The experiments have been arranged and carried out by my friends and colleagues, Messrs. Cobb, Evans, Shawcross, Welbourn, and Keigwin ; you will, I am sure, agree with me that they have done their work well, and that they deserve our best thanks.

THE TELEPHONE QUESTION.*

BY ALFRED R. BENNETT, M.I.E.E.

(Continued from page 185.)

When the granting of a license continued to be urged, the Postmaster-General spoke of the evils which he was advised would result from the existence of two separate exchanges in the same district or town, although experience in competition, which has not been wanting even in the United Kingdom, failed to bear out his assertions that it was detrimental to the public interests. He said that the Post Office itself had reserved the right to compete in any town or district in which the service was (according to the Post Office and not to the public) unsatisfactory. But such possible Post Office competition is nothing better than a mere pretext intended to allow the existing position of things to continue, as the Post Offices charges for telephone exchange communication are considerably higher than those of the National Telephone Company itself, so that Post Office competition affords no sort of remedy to those who consider the company's charges excessive. Besides, the Post Office has demonstrated its inability to compete with the National Telephone Company. It has endeavoured to do so in many towns and districts, but with the solitary exception of Newcastle-on-Tyne, where it obtained a strong footing before the Company commenced business, the results have been in the highest degree disappointing, so much so that in several places the Post Office exchanges have ceased to exist, even in face of such opposition as was afforded by the National Telephone Company with arrangements which the Post Office engineers have always alleged to be technically inferior to their own. The offer of Post Office competition, therefore, as a remedy in places where dissatisfaction exists with the company's service is but a sorry jest. Before the late Select Committee on the Telephone Service the chairman of the National Telephone Company stated several times that his company was the agent and partner of the Post Office in the telephone business. There is no doubt that he was to a large extent justified in saying this, and that the Post Office officials have no intention to do anything which will interfere with the virtual monopoly at present possessed by that company.

Before the same Select Committee the National Telephone Company professed to be convinced that competition was no longer possible because its license will expire in 16 years from the present time, in 1911, and it is assumed that any fresh licenses which may be issued by the Post Office would be made terminable at the same time. The resulting tenure would be so brief that Mr. Forbes, on behalf of the company, said that it would be absolutely impossible for any company or municipality proposing to compete with it to raise the necessary capital. Such seasonably sceptical views are not uncommon on the part

* Paper read before the East of Scotland Engineering Association at Edinburgh, February 5, 1896.

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of chairmen of companies threatened with opposition. For instance, Sir Edward Watkin, chairman of the Manchester, Sheffield, and Lincolnshire Railway Company, predicted (see *Engineer*, August 6, 1886) that the Manchester Ship Canal would never be made, and that for a very simple reason—namely, that the necessary capital would never be raised.

Events have shown that Sir Edward Watkin was wrong, and Mr. Forbes's views in regard to the raising of capital for competing telephone exchanges were not shared by the witnesses who appeared for the Glasgow Corporation; but the assertion was repeated again and again, and apparently accepted by the Post Office officials as conclusive.

No doubt, if a company proposed to raise capital in the ordinary way for the purpose of erecting a competing system which could not have a longer life than 16 years, the task would be a difficult one; but the fact must not be lost sight of that if such a competing company erected a really good system with all modern appliances, the Post Office would be practically compelled to purchase it for at least its actual cost in the event of the license being recalled after 16 years. Then, as the Glasgow witnesses pointed out, a common good fund exists in that town which could be used for the purpose of constructing an exchange; and abroad the rates are used for the purpose in places where municipal exchanges exist, with results beneficial to the ratepayers, inasmuch as good profits are always earned. But a company might not be able to raise capital; the right of the Glasgow Corporation to use its common good fund for such a purpose might be challenged, and the Town Council might not obtain the necessary permission to use the rates for the creation of a telephone exchange. How, then, could the necessary capital for competition be obtained? Very easily, and in a manner which that, best of all tests, experience, has shown to be perfectly successful.

In several foreign countries the capital necessary for the construction of telephone exchanges has been raised by inviting those who desire to enjoy the benefits of telephonic communication to pay an amount down on their being accepted as members of the exchange, this payment down being apart from, and supplementary to, the ordinary annual subscription, which is payable in advance. Continental experience shows conclusively that telephone exchange lines with their necessary instruments do not cost more to construct than £10 or £12 each, even in such a large city as Christiania, and even when the cost of trunk lines connecting with neighbouring towns is included. Assume the case of a company or municipality wishing to construct an exchange on this system. The annual subscription would be fixed in accordance with the population of the town—in Christiania, it is £4. 8s. 11d.; in Trondhjem, it averages £2. 14s. 4d.; in Rotterdam, according to the tariff of the new exchange now being constructed for the Rotterdam Town Council, it is £6. 3s. 5d. It is desirable to have in hand at least £10 for each subscriber to be joined up, to provide which each intending subscriber would be asked to pay one year's subscription in advance, together with a contribution towards the cost of his line and apparatus. In this country a town of the size of Christiania could be telephoned at a profit for a subscription of £5. 5s. per annum, and one of the size of Trondhjem for £4. 10s. per annum. In a town of 100,000 inhabitants the necessary subscription would be £4. 15s., and in one of a population of 150,000, £5 In the case of a company or town council wishing to telephone a town of from 100,000 to 150,000 inhabitants on the plan referred to, intending subscribers would be asked to pay one year's subscription in advance—namely, £5—and either to contribute a special sum of £7, or to purchase a £7 share in the undertaking. These two sums together amount to £12, which would be sufficient to construct the line, put in the instrument, and provide the necessary switching apparatus at the exchange. As this would be done in the case of every subscriber, each man would bring the cost of his line with him, and there would be no occasion to go to the public for capital, or, in the case of a town council, to borrow or to call upon the ratepayers for any advance. It may be said that when this is done the company will have to provide for the first year's working expenses before the second annual subscription becomes due. If the amounts paid down by the subscribers in advance are not sufficient to cover this item, which in the case of a new exchange is a very insignificant one, the company could borrow money on the plant already erected, and so make good any deficiency, the borrowed money being made a first charge on the profits.

Edinburgh, with Leith, Granton, Portobello, Musselburgh, Dalkeith, etc., contains about 365,000 inhabitants. A metallic-circuit exchange comprising the latest improvements could be constructed at a cost of £16 per line, and such an exchange would be worked at a profit on a subscription of £5. 10s. per annum. The original payment by intending subscribers would be £5. 10s. + £10. 10s. = £16.

If we had to deal with towns of the largest size, such as Glasgow, Liverpool, or Manchester, the cost of the lines would be about £14, and the annual subscription necessary to work at a profit would be £5. 15s. The subscriber's original payment in this case would have to be £11. 5s. + £5. 15s. = £17.

It may be said that to call upon the subscribers to pay such an amount down as (in the case of Edinburgh) £16 would be to make too large a demand on their pockets, but when it is considered that the ordinary subscriber now pays the existing company £10 per annum in advance, whereas by the proposed plan he would pay £16 once, and only £5. 10s. per annum for all time thereafter, it will be seen that this objection is not a very weighty one. In four years he would pay only £32. 10s., instead of £40 as at present; and in five years £38, instead of £50. With such a system the possible recall of the license in 16 years possesses no importance: it would pay if the license lasted only three or four years. In that time the subscribers would have saved money on their annual payments apart from the value of the exchange, which would, nevertheless, remain their property. Besides, a subscription of £5. 10s. in Edinburgh would yield a handsome profit annually, even after paying the Post Office royalty, so that a company would have funds on its hands to dispose of in some shape or form. If shares were accepted in return for the contribution, each subscriber would be a shareholder, too, and would enjoy an annual dividend. Or, as is done by some of the Swedish, Norwegian, and Danish companies, the profit could be used for the purpose of reducing the amounts of the subscriptions instead of being paid away as ordinary dividends. It must not for an instant be assumed that an exchange provided in this way need be of the cheap and nasty order. By no means. Metallic circuits for the lines, the most modern apparatus for the instruments, and all appliances of the best sort could be provided for the sum named.

Advocates of the existing state of things will probably say that such a scheme is impracticable, and that people will not pay money down. The answer to that is that it is done in many places abroad, and what foreigners perceive to be a reasonable arrangement will not fail to recommend itself to the inhabitants of the United Kingdom. The General Telephone Company of Stockholm, which possesses more than 10,000 subscribers in the city of Stockholm and its immediate suburbs alone, is and has always been conducted on this plan. If 10,000 persons in Stockholm have been able to pay money down in the shape proposed, there cannot be anything very serious to urge against its feasibility. The plan, besides being practised in Sweden, Norway, and Denmark, has been very successful in the Grand Duchy of Finland, the telephonic exploitation of which is in the hands of companies and co-operative societies. The Governments of Austria and Roumania require their subscribers to find the capital for the construction of their lines; the French Government does the same except in Paris and Lyons; and the Luxemburg Government also brings the plan into use in certain specific cases. It is likewise well known that companies in the United States have built telephone exchanges and constructed trunk lines with no other capital than that afforded by the payment in advance of the bare subscriptions for one year. Besides, should the payment of the contribution in one sum be objected to, it would assuredly be possible to spread it over three or five years, as is done in Austria and some other countries. We may be sure, therefore, that it is quite practicable, if only the Post Office could be got to permit it, to start competing exchanges in the United Kingdom, or, at least, to establish exchanges in some of the very numerous towns and districts which are at present totally unprovided with telephonic communication without calling upon the general public to contribute any capital, without using the money of the ratepayers, and without drawing upon common good funds.

It is interesting to note that the opinions in favour of monopoly, and especially in favour of the monopoly of the National Telephone Company which are entertained by the permanent Post Office officials who appeared before the late Select Committee, and by whose influence the opinions of Postmasters-General are shaped, are not shared by all the Post Office authorities. It was admitted before the late Select Committee that the late Mr. Fawcett, one of the most distinguished Postmasters-General which we have possessed during the last few years, and the author of many beneficial reforms in the Post Office, was absolutely in favour of free competition in telephones. He thought that if the Post Office had anything better to offer to the public than that which could be obtained from private suppliers of telephone communication, then the public would adopt the Post Office plans and not those of the private competitors; if, on the other hand, the Post Office plans proved unacceptable, it was proof positive that they were not adapted to the needs of the community. The late Mr. Raikes, who was also a Postmaster-General capable of forming his own opinions, was likewise opposed to amalgamation taking place between the different licensed companies, as he looked upon monopoly as inimical, not only to the interests of the public, but to those of the Post Office also. The two gentlemen named were Postmasters-General, but their views are shared by members of the permanent staff. Mr. F. E. Baines, C.B., late Inspector-General of her Majesty's Mails, served forty years in the Post Office as an official, and during many years was the effective controller of the Post Office telegraphs. Mr. Baines, as is evidenced in his books "Forty Years at the Post Office" and "On the Track of the Mail Coach," takes an infinite

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pride in the achievements of the Post Office, and such a man would be the last to favour free telephonic competition unless his experience convinced him that it is the only method calculated to fully develop the telephonic needs of the nation. It is therefore most interesting and instructive to find that Mr. Baines is absolutely opposed to those permanent officials who are the chief advocates of the National Telephone Company, and to the late Postmaster-General, Mr. Arnold Morley. The extracts from Baines's last book, which form an appendix to this paper, leave no doubt that the present advocacy of monoply within the Post Office is more an accident of individuals than of settled departmental conviction. It will be noted that Mr. Baines is satisfied that a £5 subscription is sufficient for local requirements, and that his estimates of the cost of erection and maintenance of telephone lines do not agree with those put forward by the Post Office witnesses before the late Select Committee, but are more consonant with the experience obtained by the Mutual Telephone Company, the Christiania Telephone Company, and other independent concerns. Major-General Webber, C.B., another Post Office engineer of long experience, to whom the construction of some of the chief routes of telegraphs in the country is due, is also totally opposed to the aims and estimates of the present officials.

Some of the evidence which was given before the late Select Committee calls for special consideration at the hands of municipalities and of telephone users. Mr. Forbes, speaking for the National Telephone Company, said that in about nine years' time the tenure remaining to the company will have become so short that it will no longer pay the company to invest capital in the further development of its system. This means, therefore, that if the Post Office and the National Telephone Company are allowed their own way no person or firm will be permitted to join a telephone exchange after the year 1904, because as the company's license expires in 1911 it would not be profitable to construct any more lines. Surely this threatened stoppage in development is a matter which ought to be taken into serious consideration by municipalities. Possibly it is a threat on the part of the company intended to force an extension of its license from the Post Office, but such an alternative is almost as grave as the former one, and the existence of the threat makes the date of the final telephonic crisis 1904 instead of 1911, and a correspondingly earlier solution is consequently called for.

(To be concluded.)

BOARD OF TRADE REGULATIONS.

The following are the regulations recently adopted by the Board of Trade under the Electric Lighting Acts of 1882 and 1888. They are classified under two headings—(A) for securing the safety of the public, and (B) for ensuring a proper and sufficient supply of electrical energy.

A.—REGULATIONS FOR SECURING THE SAFETY OF THE PUBLIC.

General.

Definitions.

In the following regulations—

The expression "the order" means the Order,

The expression "the undertakers" means the undertakers for the purposes of the order.

The expression "consumer's wires" means any electric lines on a consumer's premises which are connected with the service lines of the undertakers at the consumer's terminals.

The expression "aerial line" means any electric line which is placed above ground and in the open air.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth; and—

(*a*) Where the conditions of the supply are such that the pressure may at any time exceed 500 volts if continuous, or 250 volts if alternating, but cannot exceed 3,000 volts, whether continuous or alternating, the supply shall be deemed a high-pressure supply;

(*b*) Where the conditions of the supply are such that the pressure may on either system exceed 3,000 volts, the supply shall be deemed an extra high-pressure supply.

The expressions "high pressure" and "extra high pressure" respectively are used in relation to electric lines, conductors, circuits, and apparatus, according to the conditions of the supply delivered through the same or particular portions thereof.

Where these regulations require any metallic body to be "efficiently connected with earth," it shall be connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of electrical energy.

Other expressions to which meanings are assigned in the order or in the above-mentioned Acts have the same respective meanings in these regulations.

Pressure of Supply to Consumers.

(1) The pressure of a supply delivered to any consumer shall not exceed 250 volts at any pair of terminals, except with the express approval of the Board of Trade. Such approval will only be given for special purposes, and on the joint application of the consumer and the undertakers, and the supply will be subject to such further regulations as the Board of Trade may from time to time prescribe.

Pressure of Supply to Transforming Apparatus.

(2) The pressure of a supply delivered to a transforming station or to transforming apparatus on a consumer's premises may exceed 250 volts, but shall not exceed the limits of high pressure.

Limitations of Extra High-Pressure Supply.

(3) An extra high-pressure supply shall not be given except to distributing stations, or other premises in the sole occupation of the undertakers, and with the written consent of the Board of Trade, and subject to such regulations and conditions as the Board of Trade may prescribe.

Maximum Current in Conductors.

(4) The maximum working current in any conductor shall not be sufficient to raise the temperature of the conductor or any part thereof to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such temperature to a greater extent than 30deg. F. The cross-sectional area and conductivity at joints must be sufficient to avoid local heating, and the joints must be protected against corrosion.

Minimum Size of Conductors.

(5) The sectional area of the conductor in any electric line laid or erected in any street after the date of these regulations shall not be less than the area of a circle of one-tenth of an inch diameter, and where the conductor is formed of a strand of wires each separate wire shall be as least as large as No. 20 standard wire gauge.

Specification of Insulating Material.

(6) All material used for insulating electric lines or apparatus shall be of the best quality, and thoroughly durable and efficient, having regard to the conditions of its use. Suitable provision shall be made for the protection of the insulating material against injury or removal.

If the protection so provided be wholly or partly metallic it shall be efficiently connected with earth.

Insulation Test of Electric Lines.

(7) Every main shall be tested for insulation after having been placed in position and before it is used for the purposes of supply, the testing pressure being at least 200 volts, and the undertakers shall duly record the results of the tests of each main or section of a main.

Maintenance of Insulation.

(8) The insulation of every complete circuit used for the supply of energy, including all machinery, apparatus, and devices forming part of, or in connection with, such circuit, shall be so maintained that the leakage current shall not under any conditions exceed one-thousandth part of the maximum supply current; and suitable means shall be provided for the immediate indication and localisation of leakage. Every leakage shall be remedied without delay.

Every such circuit shall be tested for insulation at least once in every week, and the undertakers shall duly record the results of the testings.

Provided that where the Board of Trade have approved of any part of any electric circuit being connected with earth, the provisions of this regulation shall not apply to that circuit so long as the connection with earth exists.

High-Pressure Conductors to be Covered.

(9) Every high-pressure conductor laid after the date of these regulations shall be continuously covered with insulating material to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulating material shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000.

Testing of Insulation of all parts of any High-Pressure Circuit.

(10) A high-pressure circuit shall not be brought into use unless the insulation of every part thereof has withstood the continuous application, during one hour, of pressure exceeding the maximum pressure to which it is intended to be subjected in use—that is to say, in the case of every electric line a pressure twice the said maximum pressure, and in the case of every machine, device, or apparatus, a pressure of 50 per cent. greater than the said maximum pressure.

The undertakers shall duly record the results of each test.

Quick-Acting Cut-Off for High-Pressure Lines, etc.

(11) Every high-pressure electric line, conductor, or other apparatus shall be protected by a suitable automatic quick-acting cut-off.

Provided that it shall not be incumbent upon the undertakers to provide such a cut-off for the outer conductor of a concentric

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main which is, with the approval of the Board of Trade, efficiently connected with earth.

Transformers.

(12) In every case where a high-pressure supply is transformed for the purpose of supply to one or more consumers, some suitable automatic and quick-acting means shall be provided to protect the consumer's wires from any accidental contact with or leakage from the high-pressure system, either within or without the transforming apparatus.

Limit of Power in High-Pressure Electric Line.

(13) A high-pressure electric line shall not be used for the transmission of more than 300,000 watts, or in the case of an aerial line 50,000 watts, except with the consent in writing of the Board of Trade, and efficient means shall be provided to prevent this limit being at any time exceeded.

Protection from Lightning.

(14) Where any portion of any electric line or any support for an electric line is exposed in such a position as to be liable to injury from lightning, it shall be efficiently protected against such injury.

Accidents to be Reported.

(15) Where any accident by explosion or fire, or any other accident of such kind as to have caused or to be likely to have caused loss of life or personal injury has occurred at any part of any electric line or work, the undertakers shall give immediate notice thereof to the Board of Trade.

AERIAL LINES WHERE ERECTED WITH THE NECESSARY CONSENTS.

Maximum Intervals between Supports.

(16) Every aerial line shall be attached to supports at intervals not exceeding 200ft. where the direction of the line is straight, or 150ft. where the direction is curved, or where the line makes a horizontal angle at the point of support.

Supports, Construction and Erection of.

(17) Every support of an aerial line shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the line, or unequal lengths of span. The factory of safety shall be for aerial lines and suspending wires at least 6, and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50lb. per square foot. No addition need be made for a possible accumulation of snow.

Every support if of metal shall be efficiently connected with earth.

Attachment of Aerial Lines.

(18) Aerial lines shall be connected to insulators, and shall be so guarded that they cannot fall away from the support. Conductors covered with insulating material shall not be attached to the insulators by uninsulated metal binders.

Height from Ground and Distance from Buildings, etc.

(19) An aerial line shall not in any part thereof be at a less height from the ground than 18ft.,* or where it crosses a street 30ft.,* or within 5ft. measured horizontally, or 7ft. measured vertically from any building or erection other than a support for the line, except where brought into a building for the purpose of supply.

Service Lines from Aerial Lines.

(20) Service lines from aerial lines shall be led as directly as possible to insulators firmly attached to some portion of the consumer's premises which is not accessible to any person without the use of a ladder or other special appliance, and from this point of attachment they shall be enclosed and protected in accordance with the subsequent regulations as to electric lines on the consumer's premises. Every portion of any service line which is outside a building, but is within 7ft. from the building, shall be completely enclosed in stout indiarubber tubing.

Angle of Crossing Thoroughfares.

(21) Where an aerial line crosses a street, the angle between the line and the direction of the street at the place of crossing shall not be less than 60deg., and the spans shall be as short as possible.

Crossing Wires, etc.

(22) Where an aerial line crosses, or is in proximity to any metallic substance, precautions shall be taken by the undertakers against the possibility of the line coming into contact with the metallic substance, or of the metallic substance coming into contact with the line by breakage or otherwise.

Suspending Wires.

(23) Every high-pressure aerial line shall be efficiently suspended by means of insulating ligaments to suspending wires, so that the weight of the line does not produce any sensible stress in the direction of its length. All suspending wires, if of iron or steel, shall be galvanised.

Discharge of Pressure in Case of Fire.

(24) In the case of any high-pressure aerial line exceeding one-half mile in total length, means shall be provided whereby the pressure may be discharged from any portion of the line erected over or alongside of any building or buildings without loss of time in case of fire or other emergency.

Maintenance.

(25) Every aerial line, including its supports and all the structural parts and electrical appliances and devices belonging to or connected with the line, shall be duly and efficiently supervised and maintained as regards both electrical and mechanical conditions.

Unused Aerial Lines to be Removed.

(26) An aerial line shall not be permitted to remain erected after it has ceased to be used for the supply of energy, unless the undertakers intend within a reasonable time again to take it into use.

ELECTRIC LINES OTHER THAN AERIAL LINES.

Construction of Receptacles for Electrical Lines.

(27) All conduits, pipes, casings, and street boxes used as receptacles for electric lines shall be constructed of durable material, and where laid under carriageways shall be of ample strength to prevent damage from heavy traffic; and reasonable means shall be taken by the undertakers to prevent accumulation of gas in such receptacles.

Crossing Pipes, etc.

(28) Where any electric line crosses, or is in proximity to, any metallic substance, special precautions shall be taken by the undertakers against the possibility of any electrical discharge to the metallic substance from the line or from any metal conduit pipe or casing enclosing the line.

Electric Continuity of Metal Conduits, Pipes, or Casing.

(29) All metal conduits, pipes, or casings containing any electric line shall be efficiently connected with earth; and shall be so jointed and connected across all street boxes and other openings as to make good electrical connection throughout their whole length.

Precautions Against Charging of Short Lengths of Pipe, etc.

(30) Where isolated lengths of metal conduit, pipe, or casing are used for the protection of any electric line at road crossings or similar positions, special precautions shall be taken to prevent the possibility of any electrical charging thereof.

Precautions to be Taken when Bare Conductors are Used.

(31) Where the conductors of electric lines placed in any conduit are not continuously covered with insulating material, they shall be secured in position, and no unfixed uninsulated material of a conducting nature shall be contained in the conduit. No such conductor shall be at a higher potential than 300 volts.

Adequate precautions shall also be taken to ensure that no accumulation of water shall take place in any part of the conduit, and to prevent any dangerous access of moisture to the conductors or the insulators.

In the case of any such electric lines laid in conduits after the date of these regulations, the insulators shall be so disposed that they can be readily inspected.

High-Pressure Lines Laid Above Ground.

(32) Every portion of any high-pressure electric line placed above the surface of the ground, or in any subway not in the sole occupation of the undertakers, shall be completely enclosed either in a tube of highly insulating material embedded in brickwork, masonry, or cement concrete, or in strong metal casing efficiently connected with earth.

High-Pressure Lines Laid in Proximity to Other Electric Lines or to the Surface of the Ground.

(33) Where any high-pressure electric line is laid beneath the surface of the ground efficient means shall be taken to render it impossible that the surface of the ground or any neighbouring electric line or conductor shall become charged by leakage from the high-pressure electric line.

Street Boxes.

(34) In addition to the provisions contained in regulation 27 as to the construction of receptacles for electric lines, the following regulations shall be observed with respect to the construction of street boxes.

(*a*) The covers of all street boxes shall be so secured that they cannot be opened except by means of a special appliance.

(*b*) The covers of all street boxes containing high-pressure apparatus other than cables shall be connected to strips of metal laid immediately underneath the adjacent roadway, and efficient means shall be taken to render it impossible that the covers or other exposed parts of these boxes, or any adjacent material forming the surface of the street, shall become electrically charged, whether by reason of leakage, defect, or otherwise.

(*c*) Where street boxes are used as transformer chambers, reasonable means shall be taken to prevent as far as possible any influx of water, either from the adjacent soil or by means of pipes; and in the case of any such street box exceeding one cubic yard in capacity, ample provision shall be made, by ventilation or otherwise, for the immediate escape of any gas which may by accident have obtained access to the box and for the prevention of danger from sparking.

(*d*) All street boxes shall be regularly inspected for the presence of gas, and if any influx or accumulation is discovered, the undertakers shall give immediate notice to the authority or company whose gas-mains are laid in the neighbourhood of the street box.

Transforming Stations.

(35) Transforming stations, or points in a system of distribution in which a high-pressure supply is transformed for the purpose of supply to consumers, and which are not on the consumer's premises, shall be established in suitable places which are in the sole occupation and charge of the undertakers,

* Note.—In the county of London 20ft. and 35ft.

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CONSUMER'S PREMISES.

Responsibility of Undertakers for their Lines, etc., on Consumer's Premises.

(36) The undertakers shall be responsible for all electric lines, fittings, and apparatus belonging to them, or under their control, which may be upon a consumer's premises, being maintained in a safe condition and in all respects fit for supplying energy.

Fire Risks.

(37) In delivering the energy to a consumer's terminals the undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises.

Main Fuses or Disconnectors to be Provided in a Locked Receptacle.

(38) A suitable safety fuse or other automatic disconnector shall be inserted in each service line within a consumer's premises as close as possible to the point of entry, and contained within a suitable locked or sealed receptacle of fireproof construction, except in cases where the service line is protected by fuses in a street box.

Treatment of Electric Lines and Apparatus on Consumer's Premises.

(39) All electric lines and apparatus placed on a consumer's premises shall be highly insulated and thoroughly protected against injury to the insulation or access of moisture, and any metal forming part of the electric circuit shall not, unless efficiently connnected with earth, be exposed so that it can be touched. All electric lines shall be so fixed and protected as to prevent the possibility of electrical discharge to any adjacent metallic substance.

Transformers and High-Pressure Apparatus to be Enclosed in Metal.

(40) Where the general supply of energy is a high-pressure supply, and transforming apparatus is installed on a consumer's premises, the whole of the high-pressure service lines, conductors, and apparatus, including the transforming apparatus itself so far as they are on the consumer's premises, shall be completely enclosed in solid walls, or in strong metal casing efficiently connected with earth and securely fastened throughout.

Connection to Consumer not to be made where Leakage would result.

(41) The undertakers shall not connect the wires and fittings on a consumer's premises with their mains unless they are reasonably satisfied that the connection would not cause a leakage from those wires and fittings exceeding one ten-thousandth part of the maximum supply current to the premises; and where the undertakers decline to make such connection they shall serve upon the consumer a notice stating their reasons for so declining.

Discontinuance of Supply on Discovery of Leakage on Consumer's Premises.

(42) If the undertakers are reasonably satisfied, after making all proper examination by testing or otherwise, that a leakage exists at some part of a circuit of such extent as to be a source of danger, and that such leakage does not exist at any part of the circuit belonging to the undertakers, then and in such case any officer of the undertakers, duly authorised by them in writing, or, if the undertakers so require, an electric inspector, may, for the purpose of discovering whether the leakage exists at any part of a circuit within or upon any consumer's premises, by notice require the consumer at some reasonable time, after the service of the notice to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit.

In any case where the undertakers require the services of an electric inspector under this regulation they shall pay him the prescribed fee.

If on such testing the officer or the electric inspector discovers a leakage from the consumer's wires exceeding one ten-thousandth part of the maximum supply current to the premises, or if the consumer does not give all due facilities for inspection and testing, the undertakers shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of the discontinuance to the consumer, and shall not recommence the supply until they are reasonably satisfied that the connection with earth has been removed. This regulation shall not affect any power contained in the order or otherwise enabling the undertakers to discontinue the supply.

Appeal to Electric Inspector.

(43) If any consumer is dissatisfied with the action of the undertakers in refusing to give or in discontinuing or in not recommencing the supply of energy to his premises, the wires and fittings of that consumer may, on his application and on payment of the prescribed fee, be tested for the existence of leakage by an electric inspector.

This regulation shall be endorsed on every notice given under the provisions of either of the two last preceding regulations.

ARC LIGHTING.

Arc Lamps to be Guarded.

(44) All arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and shall not be used in situations where there is any danger of the presence of explosive dust or gas.

Height from Ground.

(45) Arc lamps used in any street for public lighting shall be so fixed as not to be in any part at a less height than 10ft. from the ground.

Cut-off Switch.

(46) Arc lamps used in any street for private lighting shall be fixed so as not to be in any part at a less height than 8ft. from the ground, and shall be so screened as to prevent risk of contact with persons. A cut-off switch, fixed in a suitable locked receptacle, shall be provided for every high-pressure arc lamp, and such switch shall be of such pattern and construction as will provide:

(*a*) That the lamp can by its means be entirely disconnected from the supply circuit;

(*b*) That the switch itself can be safely operated in the dark without special precautions; and

(*c*) That there shall be no danger of any injurious electrical arcing, sparking, or heating being caused by the operation of the switch.

Penalties for Default.

(47) If the undertakers make default in complying with any of the preceding regulations, they shall on conviction be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10.

The recovery of a penalty under these regulations shall not affect the liability of the undertakers to make compensation in respect of any damage or injury which may be caused by reason of the default.

B.—REGULATIONS FOR SECURING A PROPER AND SUFFICIENT SUPPLY OF ELECTRICAL ENERGY.

Notice of Intention to Supply through Mains.

(1) Forty-eight hours at least before the undertakers are ready to commence to supply energy through any feeding, charging, or distributing main, they shall serve notice upon the local authority of their intention to commence such supply.

Undertakers to Provide Constant Supply.

(2) From and after the time when the undertakers commence to supply energy through any distributing main, they shall maintain a supply of sufficient power for the use of all the consumers for the time being entitled to be supplied from such main; and such supply shall, except so far as may be otherwise agreed upon from time to time between the local authority and the undertakers, be constantly maintained. Provided that, for the purposes of testing, or for any other purposes connected with the efficient working of the undertaking, the authority by whom the electric inspector is appointed may give permission to the undertakers to discontinue the supply at such intervals of time and for such periods as that authority may think expedient. When the supply is so discontinued, notice of such discontinuance, and of the probable duration thereof, shall be forthwith served upon the local authority.

Provisions as Regards Stoppage.

(3) The system of distributing mains shall be so arranged that in case it becomes necessary to stop the supply through any portion of a main for more than one hour for the purposes of repairs, or for any other reason, the stoppage of supply will in no case exceed in amount a maximum power of 200,000 watts, or extend to the premises of more than 80 consumers, and in the case of every stoppage for more than one hour reasonable notice shall be previously given by the undertakers to every consumer affected thereby except in cases of emergency.

Pressure in Mains During Supply.

(4) During the whole of the period when a supply of energy is required to be maintained by the undertakers in the distributing mains under the order and these regulations, it shall be maintained at a constant pressure in these regulations termed the "standard pressure," but the standard pressure may be different for different portions of the distributing mains. Provided that the undertakers shall be deemed to have complied with the requirements of this regulation so long as the pressure does not at any point vary more than 2 per cent. from the corresponding standard pressure in the case of a general supply at high pressure, or 3 per cent. in other cases, unless changes in pressure recur so frequently as to cause unsteadiness in the supply.

Fixing of Standard Pressure.

(5) The standard pressure shall be fixed by the undertakers, and notice of the amount of such standard pressure shall be given to the local authority before the undertakers commence to supply energy to consumers, and such standard pressure shall not be altered except by permission of the local authority, and upon such terms and conditions as the local authority may impose, and after public notice has been given during a period of one month in such manner as the local authority may require, of the intention of the undertakers to apply for permission to alter the same. The undertakers may appeal against any decision of the local authority under this regulation to the Board of Trade, whose decision shall be final.

Declared Pressure at Consumer's Terminals.

(6) Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In the case of a transformation of energy on the consumer's premises, the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be the declared constant pressure.

Provided that no change shall be made in the pressure of the

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supply to any premises which at the date of these regulations are supplied with energy by the undertakers except with the consent of the consumer.

Variation of Pressure at Consumer's Terminals.

(7) The variation of pressure at any consumer's terminals shall not under any conditions of the supply which the consumer is entitled to receive exceed 4 per cent. from the declared constant pressure.

Penalty for Default.

(8) If the undertakers make default in complying with any of these regulations as to supply, they shall, subject to the provisions of the order, be liable on conviction to a penalty not exceeding £5 for every such default, and to a daily penalty not exceeding £5.

These regulations are made subject to the power of the Board of Trade to make such further or other regulations as they may think expedient; and nothing in these regulations shall be construed to authorise the undertakers to lay any electric line or work their undertaking otherwise than in accordance with the order and the principal Act, or to supply energy otherwise than by a system for the time being approved of by the Board of Trade under the order.

THE CHELTENHAM ACCIDENT.

The following is the report of Major Cardew to the Board of Trade as to the causes of the fatal accident in connection with the electric light supply of the Cheltenham Corporation:

I have the honour to report, for the information of the Board of Trade, that, in compliance with the instructions contained in your minute of the 3rd inst., I have held an enquiry into the cause of the death of John Pugh, mechanic, on the 16th ult., while employed by the Corporation of Cheltenham in carrying out some alterations in one of the transforming chambers used by this Corporation for the purposes of their electric light supply. The enquiry was held on the 15th inst. The following witnesses were examined—viz., Leicester Richards Lee, engineer; Richard Edwards, jointer; M. H. Kilgour, borough electrical engineer; Richard Cresswell, D.Ph., surgeon. They severally confirmed the evidence previously given by them at the coroner's inquest. I carefully examined the chamber in which the accident took place, and I also visited the generating station.

Account of Accident.—The circumstances of the case are, I find, as follow: The Corporation of Cheltenham supply electric energy by means of a high-pressure alternating current, at a constant pressure of 2,000 volts, which is reduced by means of transformers placed partly in transforming stations below the level of the street and partly on consumers' premises, to a pressure of 100 volts, for purposes of supply to consumers. The transforming stations are larger than those usually constructed for the purpose, and are in all respects suitable in construction. The arrangements within them consist, in addition to the transformers, of high-pressure and low-pressure switchboards for regulating purposes. The particular station in question contains an extra number of high-pressure switches, as from it is controlled the supply to another transforming station. The work upon which the party were engaged at the time of the accident was the erection of a low-pressure switchboard on the north wall, in a position closely adjacent to one of the high-pressure switchboards. The unfortunate man was at the time boring a hole in a wooden batten with a large gimlet at a distance of only about 4in. from the high-pressure switchboard, on which were fixed several switches with exposed metal surfaces charged to the full pressure of 2,000 volts. The conditions, in fact, were such that although it was possible to do the work without making contact with the charged metal, it required continual care and attention to avoid the fatal consequence of an unguarded movement. The danger was, I consider, almost equal to that of sending a man into a magazine full of loose powder with a lighted candle in his hand. From the evidence of the foreman under whom Pugh was employed it appears that the latter was decidedly careless by nature, and that before the accident happened he had been cautioned several times. An indiarubber mat had been provided as a protection to be used when working at the high-pressure switchboards, but had been moved away, probably by the men at work, as not being required, since they were not manipulating the electric circuits. Indiarubber gloves were also provided, but the use of these would certainly have been inconvenient. The accident appears to have been caused by Pugh in a moment of forgetfulness raising his left arm until it came, as it naturally would, into contact with the charged metal, in two places causing wounds as described by Dr. Cresswell, the current entering his body by this arm, and leaving it partly by his feet and partly by his right hand, assuming that he was grasping the gimlet at the time. The abrasions on the face were probably caused in his fall, either by a simple blow or a subsequent contact. Death appears to have been practically instantaneous.

Opinion and Recommendations.—In my opinion this accident is chiefly to be attributed to an error in judgment on the part of those responsible in allowing such work to be carried on in close proximity to highly-charged metal. It is too much to expect that any man, and especially an imperfectly educated man, should exercise such continual care over all the movements of his body as was necessary in this case when he is engaged upon work distracting his attention from the danger, and when the danger itself is not of a kind that appeals to the ordinary senses. I understand that had the electric pressure been switched off from the sub-station to enable the work to be done with safety, the supply to a few customers would have been interfered with to some extent. I ascertained, however, that the undertakers regularly stop supply altogether on Wednesdays for two hours in the middle of the day, and the work could have been carried out with absolute safety during this interval. The fact appears to be that the possibility of danger was unfortunately overlooked. Under ordinary conditions no work other than attention to the electrical circuits should be carried on in any transforming station when any apparatus contained therein is charged to a high pressure. In the second place, I consider that the switching arrangements on the high-pressure switchboards in use in this and other transforming stations are needlessly dangerous in that large surfaces of charged metal are exposed, which could easily be covered by solid insulating material, so as to render an accidental contact with them impossible. I was pleased to find that on the main switchboard at the generating station well-designed arrangements had been made for the guarding of all charged metal. Some similar arrangements should be carried out on the switchboards in the transforming stations. The necessity for some alteration in this respect is now fully recognised by the borough electrical engineer, who had prepared for my inspection a model of an insulating cap to partially cover the charged metal. It appeared to me, however, that the protection could be made more complete, and my suggestions are now, I understand, under consideration. Thirdly, I would suggest that in all the transforming stations a thoroughly insulated floor should be provided, as can easily be done at a small expense. The indiarubber mats at present used are probably effective, but they are easily displaced. They should be retained for use on the insulated floor as an additional precaution. There should also be in every case where it can be arranged a stout wooden rail or other division to separate off the portion of the chamber in which high-pressure apparatus is fixed.

Finally, the Board of Trade should, I consider, request the immediate attention of the Corporation of Cheltenham to the remarks and suggestions contained in this report. Those who undertake the supply of electrical energy at a pressure which involves the danger of sudden death from a cause so unnatural and so remote from human experience as the mere contact with a piece of metal, and who in their operations necessarily employ men of imperfect education, untrained to grasp abstract ideas, have a heavy moral responsibility for the safety of their employés. I feel confident that the Corporation of Cheltenham and their electrical engineer fully realise their responsibilities in this matter, and that they will spare no expense or exertion to prevent for the future any accident to their employés.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

February 25, 8 p.m.—Discussion on "The Electric Street Railway System of Montreal," by Granville C. Cuningham (member).

February 28, 8 p.m.—Students' meeting. "Loughborough Sewage-Disposal Works," by A. S. Butterworth (student).

Institution of Electrical Engineers.

February 21, 8 p.m.—At 28, Victoria-street. Students' meeting. "Some Central-Station Experience," by W. Fennell (student).

February 27, 8 p.m.—At 25, Great George-street, Westminster. Conclusion of the discussion on "The Electric Wiring Question," by F. Bathurst (associate), and "Concentric Wiring," by Sam. Mavor (member). "High-Voltage Lamps and their Influence on Central-Station Practice," by G. L. Addenbrooke (member).

Royal Institution of Great Britain.

February 22, 3 p.m.—At Albemarle-street, Piccadilly. "Light," by Lord Rayleigh, F.R.S.

Northern Society of Electrical Engineers.

February 24, 8 p.m.—At the Palatine Hotel, Hunt's Bank, Manchester. "The Development of Electric Lighting Engines," by H. Lindley (member).

Society of Arts.

February 24, 8 p.m.—At John-street, Adelphi. "The Chemistry of Metals and Alloys Employed for Building and Decorative Purposes," by Prof. J. M. Thomson, F.R.S.E. (second of three lectures).

Physical Society.

February 28, 5 p.m.—At Burlington House. "Experiments with Incandescent Lamps," by Sir D. Salomons. "The Alternating-Current Arc," by Messrs. Fleming and Petavel,

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THE

ELECTRICAL ENGINEER.

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TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

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BOUND VOLUMES.

Vol. XV. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

IMPORTANT NOTICE.

The agents of a foreign Government are making enquiries with the view of placing orders in this country. The Editor of the *Electrical Engineer* and *Contract Journal* has been asked to supply a list of Government contractors, so far as all kinds of military stores are concerned. He would be glad if any firm desirous of being placed on the list would at once communicate with him, stating the materials they are prepared to supply. The only rule to be followed is that they must be contractors to our own Government. All military stores, entrenching tools, tents, cloth, yarn, ironmongery, etc., are in request.

PROMISES AND PERFORMANCES.

It is not a profitable undertaking to call attention to the fulfilment or otherwise of promises. Politicians, it is well known, are very careful when out of office to promise in language that cannot well be translated so as to mean anything definite. Canvassers when trying to induce customers to instal the electric light promise that the cost will not be greater than the cost for gas, but of course when the bills come in these promises have to be explained away. Promoters, when trying to get subscriptions, word prospectuses so that the prospect of dividends looks golden. But it is with none of these phases of business that we will now trouble about. There seems to be signs of progress in electric traction. It is not generally known, or has made little impression, that for twenty years or so after Faraday's discoveries the aim of every designer was to obtain a motor. They had their generator in the voltaic cell, and hoped by means of an electric motor to obtain a combination that would satisfactorily compete with steam. In 1841 a small book translated from the German was issued, under the title, "Steam Superseded—An account of the newly invented electromagnetic engine for the propulsion of locomotives, ships, mills, etc., and also applicable to the processes of spinning, turning, grinding, sawing, polishing, etc., and every species of mechanical movement." For fifty years the use of motors slumbered or slept. Why they failed in the early stages of electrical activity we know; why they do not progress faster now is hardly so well known. Fifty years and more ago we were promised these applications; the fulfilment of the promise is now in a small measure taking place. Knowing as we know the vast difference in cost between electrical energy generated in a battery and transformed into mechanical energy through a motor and such energy generated and transformed by means of a dynamo and motor, it is wonderful to read the aspirations of these old designers. Thus Stoehrer, of Leipsic, stated his conviction that he could get some forty-five horse-power to propel a train of wagons with the usual number of passengers from Leipsic to Dresden on the railroad at an expense of but six shillings, "whilst the expense at present (1841) is about five pounds sterling." About the same time Wagener, of Frankfort, constructed a machine somewhat on the same lines as that of Stoehrer, for which a reward of one hundred thousand florins was guaranteed him by the German Diet "as soon as the plan shall be carried out on a large scale." It would be interesting to know the after-course of Wagener's work; all we know is that "this execution on a large scale has, according to the latest accounts, succeeded most brilliantly, for a sawmill is at present (1841) worked by electromagnetism in Bavaria, and this new power has already realised the most sanguine expectations. A locomotive is also propelled by it." Did Wagener ever get his one hundred thousand florins, or what was really the result of his experiments? Stoehrer's name is common in the books, but what of Wagener? We think that sufficient has been said to prove that the future

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of the electric motor was well foreseen in 1841 by these workers, and that they failed to realise success only for the lack of an economical generator. It is truly surprising to find a general credence that motor work is a thought or an accident of the last twenty years, instead of a knowledge that such work was the great aim of the men working in the early days of this electric era. They promised, but they failed to realise—they were looked upon as dreamers and failures; but we who live in this generation know that their dreams were destined to bear fruit, and therefore those among us who are dubbed dreamers and enthusiasts may take heart and comfort themselves with the idea that what does not come to pass now will be realised probably before the end of the next generation.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

AUTOCARS.

SIR,—A prospectus of the Daimler Motor Company reached me the same day as it was announced that the Prince of Wales was riding in a self-propelled carriage at the Imperial Institute with two vice-presidents of the Motor-car Club, who were respectively a director and the engineer of this company. I further observe that my name appears in this prospectus in bold type, presumably as a kind of advertisement for obtaining money from the public. As to whether the prospects of this company and the value of its property are good or bad, I have nothing to say. This is purely a matter with which the financial Press has to deal, but from letters which I have received, as well as from personal remarks made to me, I learn that there is an impression that I am in some way connected with or interested in the Motorcar Club and the Daimler Motor Company, the two concerns being closely related to one another, so many names being common in both. It is a source of satisfaction to me to state that I am not connected with either in any way whatever.

The prominent part which I have taken from the start in the self-propelled traffic movement, and which has now been solved by Mr. Henry Chaplin's reception of the strong deputation which I had the honour of introducing to him a few days since, has no doubt led many to believe that I have some financial interest in the question, present or future. I am anxious to disabuse such an idea. Any part I have played in this matter has been done purely out of patriotism, not desiring to see our nation in a worse position than those on the Continent.—Yours, etc.,

DAVID SALOMONS.

Broomhill, Tunbridge Wells, February 15, 1896.

USEFUL ELECTRIC LAMPS.

SIR,—In your issue of the 16th inst. there is a letter from Mr. Sydney Baynes, who is the better credited among the initiated because he openly signs it and abjures the pen name.

So far, I feel that in these days of pushing business, in which it is evident that honesty of purpose will be only known as a name within the space of a decade, I am dealing with one who like myself is not *fin de siecle*.

But I do not think Mr. Baynes has carefully studied the tests which led to the correspondence, nor read the correspondence itself upon the subject. I do not deny that German firms can turn out good lamps, but I needs must veto those which have been imported and turned over to the trade as English lamps, because of a similarity as to the outline and general appearance. These lamps are put upon the market at such a low price as to render selection out of the question, since the margin of profit on the manufacture alone is too meagre to admit of any claim respecting quality or efficiency.

I should like to know from the advocates of foreign-made goods what Germany or any other European State has done in the genesis of the incandescent lamp. England is foremost, America follows suit, and the others simply add details of more or less importance. The Edison patent held its own in Germany as forcibly as here, but the constitution of the German law is somewhat different, insomuch as it neither retarded nor ruined trade.

Mr. Baynes must suspend his judgment until other and equally reliable public tests have proved the superiority of English-made lamps, and then he will, I am sure, confess that either the Germans wasted a splendid opportunity when we were perforce in bondage, or that they export bad lamps prohibited for home use by the commission on selection test.

Any way Mr. Baynes studies the question, whether with a clock, a photometer, and a wattmeter, on actual time, illumination, and current test, or from the general aspect of the case, he must admit that "English-made lamps are the best," and that any slight extra cost due to the better class of the workmanship is refunded a hundredfold within a week, by the saving of the current supplied.—Yours, etc.,

FREDK. WALKER.

SIR,—My letter, kindly inserted by you and signed "Fair Play," has called forth a reply of doubtful value over the signature "Fredk. Walker."

It is not my desire to enter into controversy with him on any point, still less do I intend to follow him into personalities; but I should feel obliged if you would kindly find room for the enclosed translation of an article published in the *Elektrotechnische Zeitschrift*, of Berlin, on the 6th inst., and which I think points to the root of the matter.—Yours, etc.,

FAIR PLAY.

Reprint from the "Elektrotechnische Zeitschrift" of Feb. 6, 1896.

From a well authenticated quarter a letter has reached us which draws attention to the campaign which English manufacturers of incandescent lamps are carrying on in their technical journals against German makes. In this letter we read, *inter alia*, "The report of the commission for the establishing of standards for use by incandescent lamp makers at the conference of representatives of electricity works is doing incalculable harm to the German industry in this article, as shown in the advertisements in English technical journals, which will certainly not fail in their object, especially in the face of current feeling.

"Although this is not the place to enter fully into the question itself, we may be allowed to observe that the mischief to this trade would not have occurred had this important question been decided at the proper time by the union of German members of the profession or by some other authoritative body. It should be a lesson for those who appear to meddle light-heartedly with matters respecting which the criticism should be left in the hands of those only who are thoroughly familiar with all the circumstances surrounding the subject.

"A large but not particularly prominent company in London, whose chief directors are Germans, makes use of a liberal translation of the above-mentioned report in order, evidently, to depreciate German lamps in the eyes of their *pseudo-compatriots*."

It is easy to understand the desire of English manufacturers to kill German competition. Under protection of a monopoly that rests upon those very patents which the holders themselves have successfully combated in other countries, the prices of lamps in England could be maintained at a point as high as they stood a year ago, which to-day are out of all proportion to the manufacturing cost if the lamps are turned out under the latest, most approved methods. These high prices have unquestionably opposed very considerable difficulties to the development of electric lighting in England. In Germany, meanwhile, under the influence of free competition, the manufacture has been carried on ceaselessly, and the methods of production have been so improved and simplified that a perfection has been attained which has not been surpassed in any single particular by the lamps made in any other country in the world. Thus it is but natural that the importation of German lamps should be highly *inconvenient* to English makers!

The representatives of electricity works certainly cannot have intended, when publishing their deliberations, to forge weapons against native productions, for their remarks and investigations were not confined to German lamps alone, but rather to incandescent lamps in general, imported from, *inter alia*, Austria, Holland, and Sweden.

It should, therefore, be an incentive to the determining of a *uniform standard* of comparison for all incandescent lamps. That the creation of such a standard should be left to the

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discretion of the Union of German Technical Experts is wisely suggested in the above-mentioned letter, because in this union every department of the electrical profession is fully represented, from whose co-operation really fruitful results can be reasonably hoped for.

REVIEWS.

Dynamo-Electric Machinery. By SILVANUS P. THOMPSON, D Sc., B.A , F.R S E. and F. N. Spon.

The fifth edition of this manual is now before us, and we are glad to note that the usual custom of addition only has not been followed in revising the previous issues. On the other hand, a large amount of the old matter of the fourth edition has been cut out, and other elementary parts have been condensed to make room for new information. Thus, the total number of pages, which in the previous edition was 864, has been reduced to 835, and the number of plate illustrations has been reduced from 29 to 19. The result is a much more handy volume, and hence a more useful one. We would, however, suggest that more attention should be given to the cuttings from books, catalogues, and newspapers so largely incorporated in the text to ensure that the same terms are not used for totally different things, and also to explain contradictory statements. Thus, referring to the external armature type of direct-current machines manufactured in Germany, the information is volunteered that "the outer part of the windings are non-inductive or idle." Neither of these terms is in any way correctly applied, and both tend to confuse the student. The term "non-inductive" is particularly open to objection. In other places, where the matter has stood through several editions, we notice that the tendency to generalise has allowed several paragraphs to appear which practice would condemn. Thus, referring to a shunt dynamo, the author says: "For a set of lamps in series the power of a shunt dynamo to supply the needful current increases with the demands of the circuit, since any added resistance sends additional current round the shunt in which the field magnets are placed, and so makes the magnetic field more intense." If this paragraph is read literally, a shunt machine should be *sine quâ non* for series working. To understand it correctly, a reader must have a critical knowledge of the subject which, certainly is not possessed by the student. It is this want of a critical examination of the useful extracts from the writing of experts that this book is deficient. We should say that, as a collection of references likely to be useful to students, it is unrivalled, but not every writer on a given subject is qualified to give a decided opinion on that subject.

As an example of this we would refer to p. 368, where, in speaking of the magnetic flux density allowable in dynamos, we find at the head of a table of maximum value, the statement that "as a rule the higher flux densities are admissible in the larger sizes only." This statement is directly in opposition to the English practice, but is supported by an American author, whose theories the author states to be wrong. The list of Edison dynamos, given a few pages further on, also contradicts the statement. Again, in the new chapter on transformer design, the author gives a series of useful hints on the best methods of procedure in designing, which are culled from various sources, and then proceeds to generalise on the effect of alterations of frequency. He concludes that "if a transformer designed for a 2,000-volt circuit at 100 periods is used on a system at 50 periods, it ought to be rated at a lower voltage, say, as a 1,000-volt transformer, or else rewound." And, again, that "for a given total loss, the output of a given transformer is proportional to the frequency." Any maker's list would be enough to disprove these absurd statements, but the application of the formulæ and rules previously given is all that is required. The chapters dealing with alternators and their design are valuable, on account of the foreign machines illustrated and described. The sections of these alternating-current generators and motors will give the reader much information as to the Continental practice. One intricate piece of reasoning on p. 647 is worthy of note. Speaking of two alternators in parallel supplying lamps, we learn that they are really working in series with one another if the lamps are disconnected. Again, on p. 752, we find the author's opinion is that "the electric tension or stress to which the dielectric is subjected tending to pierce it, varies as the square of the volts." So we presume that a test at twice the normal voltage would result in four times the normal strain. Also, we suppose that a cable for 10,000 volts would require a thickness of insulation ten thousand times that for a 100-volt cable. If these faults had occurred in earlier editions only we should have refrained from referring to them, but their repetition demands notice. The illustrations throughout the book are well executed, and the plates at the end are worthy of special commendation.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of this Institution on **Thursday, February 13**, the president (Dr. Hopkinson) in the chair,

The **Secretary** read the formal acknowledgment from the Secretary of State of the resolution of condolence on the death of Prince Henry of Battenberg passed by the Institution.

The discussion on the wiring question was then resumed.

Mr. Andrews, after acknowledging what had been said at the former meeting as to his share in the invention of concentric wiring, remarked that on its first introduction concentric wiring was opposed to the existing practice and was received with great opposition on the part of the insurance companies, who for the most part followed the Phœnix rules. That opposition, he was happy to say had now died out. He could not say that he approved of Mr. Mavor's proposals for the inspection of installations by the insurance offices, and he did not think that English contractors should be regarded with such distrust as had been suggested by the remarks of some of the speakers. After referring to the system to be adopted in Guildford, Mr. Andrews said that with an earthed concentric system a more perfect balance could be maintained than with three separate conductors. A wide introduction of concentric wiring would considerably reduce the service mains and joints, but the principal reduction would be in the reduction of the cost of interior wiring. Of course its introduction was dependent upon permission to earth the outer, but doing this would be a great advantage, as the course of any leakage current would be reduced. If there was a leakage in a house, it would be confined to that house. When he spoke of earthing he did not mean at one point only, but all along the system, though of course he did not advocate bare conductors. All the way from the dynamo to the lamp the outer conductor should be so close to the inner that an arc could not be established without blowing a fuse. The insulating material in concentric wiring should be substantial, but it need not be more than enough to prevent such a leakage as was detrimental in a commercial sense.

Mr. Wallis Jones remarked that, looking back on the progress of electric wiring since 1881, it would be found that they had passed through three periods—the stone age, the wooden age, and the iron age. He believed the present, the iron age, had come to stay. In the absence of moisture almost any system of wiring was good enough, but in the presence of damp wood casing was very uncertain. He had known a case in which the conductor, a nineteen-sixteens cable, had absolutely dissolved away owing to the action of moisture from a burst water-pipe. If a new building had to be wired on a two-wire system, there was nothing so good, he thought, as the interior insulated conduit system. The concentric wiring system elaborated by Mr. Mavor was a most admirable one in the case of an isolated plant, but imagined there would be difficulty in the way of applying it to finished buildings in a sightly manner unless with the hollow walls as used in Scotland. In a conduit system it was possible to draw in and out considerable lengths of wire, and 60ft. or 70ft. circuit runs from distributor points might be conveniently used. He believed, on the ground of expense, that the conduit might be improved by reducing its diameter, thereby saving the cutting away of chases in brickwork.

Mr. Addenbrooke, referring to the financial aspect of wiring, said that, assuming the central station and mains cost about £100 per kilowatt, then, taking a fair proportion of 8-c.p. and 16-c.p. lamps, this would light about 20. But there might safely be 40 wired, so that, put the wiring at £1 per lamp, it worked out £40 for lamps and wiring for every £100 for central station and mains. The question of wiring was therefore a most important one from a financial point of view, since it was greater than any other single item, such as boilers or engines. It would, he thought, be very difficult to make the progress that they wanted unless earthing the central wire was allowed. One of the great obstacles in the introduction of the electric light was the great cost of wiring houses. Landlords would not bear the expense, and tenants could not make them; consequently there were numbers of people who would gladly pay for the current, but who went without the electric light because of the initial expense. To perfect a new system, a great many branches of manufacture must be taken up, and this had deterred many people from attacking the question of producing something to supersede wooden casing. Moreover, people were afraid of a new system, if it confined them to getting their fittings from one firm.

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As far as convenience went, he thought Mr. Mavor's system was the best, and having asked for estimates for wiring a steamer he had obtained two on the concentric system which were under those on the double-wire system. In reference to electrolysis, if the middle wire was earthed at the distributing point and not at the feeders, there would be under existing practice an outside difference of three volts. So that, halving this for the middle wire, and allowing for the house, they would be left with a fraction of a volt available for electrolysis—an amount which ought not to be sufficient to produce it.

Mr. Russell congratulated the readers of the papers upon their work, but would have liked to have had further figures from Mr. Bathurst on the subject of reducing the cost by his system Having had experience with plain iron tubes, he found that the bogies of rust and condensation had not existence. This made a good job, but could not compete with cheap work at 15s. per lamp. To greatly reduce the cost of wiring, they must have a new system entirely. He would be glad to see the formation of a class of registered wiremen something like the registered plumbers. That would give confidence to customers, raise prices, and give them all a better chance.

Prof. Ayrton said that he had some time ago worked out the question of what was an economical cross-section as apart from what was a safe one, and he had found that the economic gauge of wire was generally much greater than one that would be safe from anydanger of heating. He did not think that the average contractor realised that the bare cost of the insulated wire was a very small fraction of the sum charged for putting a number of lamps into a house. Take the extreme case, say, 10 16-c.p. lamps on the top storey of a house, and say it is necessary to carry the current 100ft. up to the lamps and 100ft. down again. Allowing a 2 per cent. drop of potential, the actual cost of vulcanised wire for those 10 lamps would be 12s. With a 1 per cent. drop it would cost 17s.—that is, the difference was 5s. Theoretically, 98-volt lamps might be used in the one case and 99-volt lamps in the other, so that 1 per cent. more would have to be paid for current with the 2 per cent. drop if the same amount of light was produced. On the basis of 1,000 hours per year and 6d. per unit this worked out about 3s., so that the thicker wire would pay for itself in less than two years. But in practice 100-volt lamps would be used, in which case the difference of a volt would make about 7 per cent. difference in the light, so that by paying 5s. more for the wire there would be a saving of 7 per cent. on 300s., the yearly bill for electric energy, or 21s. per annum. He had spent a good deal of time in endeavouring to work out the best drop from an economic point of view, and as a result found that it paid to put in as large a cross-section of copper as could be done without materially increasing the cost of labour. This result led to another one—namely, that a great number of fuses might be dispensed with. Showing a flexible wire intended to carry 0 6 ampere at 450 amperes per squre inch, Prof. Ayrton remarked that it had had 35 amperes through it without heating, so that it would be absolutely safe without any fuses if attached to wires on which there was anywhere a 15-ampere fuse. Such fuses as were used should be of the same kind, or, if not, they should be absolutely non-interchangeable. In conclusion, he might mention, in reference to what had been said by Mr. Russell, that a practical examination for wiremen had been started this year by the City and Guilds Institute.

Prof. Silvanus Thompson began by calling attention to the paragraph in Mr. Bathurst's paper: "If a defect occurs so that there is electrical contact between the conductor and the pipe, with two conductors in the pipe an unanticipated electrical condition prevails because one conductor is now of greater carrying capacity than the other, which has been increased by the capacity of the tube itself. Overheating of the intact conductor can now invite serious trouble at any point; also, that failure of insulation on one wire means that the voltage tending to break down the other is doubled, and the actual strain increased fourfold." Prof. Thompson remarked in reference to this that where there was a very high electrical resistance obtained by using a thin material of good quality, there was an advantage in lining the pipe and so obtaining a double insulation. Prof. Thompson described a method he had adopted in wiring his own house, where a flexible double-wire cable was produced by using lead covering. Prof. Thompson also contended that fuses in a ceiling rose were most objectionable, as it was impossible to get at them, and all fuses should be so made as to be replaceable without difficulty while the current was on. One disadvantage of systems in which the wires could not be taken out was that it was impossible to add materially to the number of lamps. In conclusion, reference had been made to the iron age as having come to say. There were some people who thought it was to be succeeded by the aluminium age. If so, by means of the new photography they would be able to inspect the joints and wires *in situ*.

Mr. Mavor, who stated that he would be unable to be present at the next meeting, when the discussion is to conclude, then replied upon it so far as it had gone. He thought the insurance companies were right in insisting on a high standard of insulation while wood casing was used, because it was only by exacting a very high standard that they could secure "good work of this bad kind." In reply to Mr. Geipel, he thought it one of the advantages of his system that it required a workman that could make a solder joint and that it could not be done by joiners. He protested against one of the illustrations in Mr. Bathurst's paper, which was a libel on concentric conductors. Mr. Langdon's suggestion as to inspection of installations by supply companies he did not agree with. It was not their business. Moreover, it left out the thousands of isolated installations. Mr. Swinton was mistaken in supposing that the contractor would require two staffs of workmen. There was nothing in his system that any man who could use a soldering bolt could not pick up in half an hour. Moreover, the expense for labour on the job was much reduced, and that, as they knew, was a kind of labour that was particularly difficult to supervise. The current capacity of the wire had little to do with the fuse. The fuse should be proportioned to the maximum current intended to be used. The danger was not general heating of the conductor, but heating at one point. It was advisable to limit the amount of current in any one conductor in a building. With reference to Mr. Antill's criticism on his curve of wiremen's employment, it represented Glasgow, and most of the work was in shops and offices, and would be finished in two or three weeks. As to earthing, it should, in his opinion, be done at the feeding points, and should be removable for testing purposes. He could not understand why some people wanted to keep drawing their wires in and out of tubes. In conclusion, he regretted that so long a time had elapsed since the papers had been read. Indeed, to judge from their speeches, some of the members seemed to have forgotten that they ever were read.

The discussion was then adjourned to February 27.

LEGAL INTELLIGENCE.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

In the Queen's Bench Division the action of the South Staffordshire Tramways Company *v.* Ebbsmith and Wain occupied the Lord Chief Justice and a special jury for five days, and was finished on Tuesday. The action was brought to recover damages from the defendants for fraudulent conspiracy while they occupied the fiduciary positions of solicitor and chairman respectively to the South Staffordshire and Birmingham District Steam Tramways Company, Limited, by which they had induced that company, whose property and rights were under an Act of 1889 taken over by the plaintiff company, to purchase from them certain unnecessary land and worthless patents; and to recover secret profits and moneys of the company used by the defendants in packing meetings of the shareholders; and for recission of the contracts for the purchase of the said land and patents.

The company was incorporated in May, 1882, with a nominal capital of £350 000, of which £260,000 was actually subscribed. There were also preference shares to the amount of £76,000, making the total capital £336,000 In addition to that the company raised about £30,000 in debentures. The defendant Mr. Ebbsmith was appointed local solicitor to the company in March 1882, and sole solicitor in March, 1887, which position he continued to hold till April, 1889, when he resigned his connection as solicitor, merely continuing as Parliamentary solicitor for the purpose of conducting a Bill through Parliament. The defendant Wain was appointed chairman in October, 1885, continuing in that capacity down to 1894. The defendant Ebbsmith in January, 1886, formed a company called the Dickinson Company, to which company he assigned his patents for a lifeguard, etc., receiving all the shares of the company in payment therefor, except the seven signatories' shares. It appeared that the defendant Mr. Ebbsmith, who had acquired 13 acres of land at Wednesbury for £1,000, transferred 2¾ acres of that land to the company for a consideration of £7,122. 10s. which with £100 for the assignment of the lease, and £91. 16s. for costs, made the figures in respect of the land £7,313. 6s. The plaintiffs' case was this was an extravagant profit, that no independent valuation was made of the land, which was not worth more than £700, and that the transaction was an abuse of the defendant's position as solicitor of the company. The plaintiffs also alleged that the meeting at which the resolutions for taking the land, etc., were passed was packed, a sum of £362 being expended in various ways, such as hire of saloon railway carriages, luncheons, etc As to the patents, the case for the plaintiffs was that too much money had been paid for the rights of the defendant Ebbsmith.

The defendant **Ebbsmith** denied that the circumstances connected with the sale of the Wednesbury property to the company were in any way kept secret. With regard to the patents, he bought the road and rail car from Dickinson. He thought it good, and did not know where it was made. There was no secrecy in the matter.

On behalf of the defendant Wain, **Mr. Kemp** submitted that the defendant had no fraudulent knowledge or intention.

The **Lord Chief Justice** having summed up, the jury found that in the matter of the sale of the land the defendants acted in concert and thereby defrauded the company, and that the damages in respect of that were £7,313, to which was to be added interest at 3½ per cent. from 1887. They also found that as regards the patents there was a conspiracy between Smith and Wain to obtain payment of sums for royalties, and that the charges made for the apparatus should have been sufficient to include royalties. On that head they assessed the damages at £2,150. As to the packed meeting, they found there was a misappropriation of the funds, and that £362 was to be given in regard to that, with interest at 3½ per cent. from the date of payment. Judgment was entered accordingly.

HOPKINSON'S GAUGES.

Last week Mr. Justice North, in the High Court of Justice, heard an action brought by Messrs J Hopkinson and Co., Limited, of Britannia Works, Huddersfield, and of Queen Victoria-street, London, jointly with Messrs. J Dewrance and Co., of Great Dover-street, London, engineers, to restrain the defendant, a

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brassfounder, at Devonshire Brassworks, Keighley, from infringing the joint patent rights of the plaintiffs for the manufacture of improved water-gauges. Mr. R. W. Wallace, Q.C., and Mr. Arthur Pagett (instructed by Messrs. Learoyd and Co.) appeared for the plaintiffs. The defendant was perpetually restrained from continuing to infringe, ordered to withdraw all infringements from his customers and his advertisements, to deliver to the plaintiffs all infringing gauges, and to pay the costs of the action.

COMPANIES' MEETINGS AND REPORTS.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY.

The annual meeting of this company was held at Newcastle last week, Mr. John D. Milburn, chairman of the directors, presiding.

The report has already been published, and the **Chairman**, in moving its adoption, said that it was gratifying to state that their output was still on the increase. They had issued no new shares because they required no extra money. They were keeping up a depreciation fund; they were fully alive to the value of it, and intended to continue it.

Sir B. C. Browne seconded, and the reports were adopted.

The **Chairman** moved that a dividend at the rate of 4 per cent. for the half-year ending December 31, making 6½ per cent. on the year, be paid.

Mr. J. B. Simpson seconded, and this was agreed to. It was decided that the directors' fees remain as before. Sir B. C. Browne and Colonel H. S. Dyer were re-elected directors; Messrs. Strachan and Co. were reappointed auditors.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

The ordinary general meeting of this Company was held at their offices, Eccleston-place, Belgravia, S.W., on Wednesday. In the absence (through illness) of the chairman of the Board (Right Hon. Lord Suffield, K.C.B.), Mr. James Heslop Powell presided.

In moving the adoption of the report and accounts, a copy of which appeared in our last week's issue, the **Chairman** first referred to the illness of Lord Suffield, who, he was pleased to say, was now much better. The directors thought that the report presented would be considered satisfactory by every shareholder. The public had soon become aware of the advantages of the electric light; that it not only gave the best illuminating power, but was accompanied by no bad air or undue heat, which was not the case with all other illuminants, and the Company's accounts proved that the public believed the Company's system was safe, reliable, and inexpensive The number of lamps installed on January 1, 1895, was 167,703, which had been increased by the end of the year to 210,982, while applications had then been received for 6,478 lights in addition. The increase both in the number of the lamps and of their customers was steadily maintained, although the field they drew upon had decreased. Their capital charges during the past year had increased by about £33,000, or about 8 per cent., but during the same time their revenue had increased by 32 per cent.—from £53,407 in 1894 to £70,511 last year—and their net revenue had increased by £12,410 on the capital expenditure mentioned of £33,000. They regretted to notice that the charge for fire insurance had increased. They had taken every possible means which they knew of to make their buildings practically fireproof, and they had purchased and had on the premises every mechanical appliance known to them for extinguishing fire if one should happen. Moreover, their men were drilled in the use of these appliances. In regard to their revenue the receipt per light was fractionally, but only fractionally, higher than it was in 1894. The increase in their business was not spasmodic, but was all along the line. In regard to depreciation, shareholders generally differed as to how much should be carried to that account. Some had written commending the directors' judgment in placing so large a sum to this account, but a few had expressed the opinion that £9,784 was an excessive amount to put by. The Board had fixed on this figure by following implicitly the advice of their eminent consulting engineer. Prof. Kennedy had divided the respective values of their plant and machinery according to their cost, and had allowed different percentages on each class, with a due regard to how they were likely to wear out. He (the chairman) remarked that his own opinion on such a subject was worth very little, but he might say that he had seen in other undertakings very evil effects arise from not having carried right principles into practice in dealing with depreciation. He had explained at a former meeting that it was necessary to establish a sinking fund to provide for the recoupment of the money paid for their leases, and that they ought to have a reserve fund to provide against any contingency that might happen. Should new discoveries antiquate their machinery or some accident befall it, particularly at a time when the business life of the corporation was coming to an end, and they might be unable to issue new shares advantageously, or to borrow on the security of their undertaking on low terms, a reserve fund invested outside their business, in first-class trustees' securities, would prove very useful to them; and even if no contingency arose, or accident happened, such a reserve fund would be a pleasant bonus for the shareholders at the end of their career. They had therefore invested £3,773 as the nucleus of a reserve fund, and £8,000, the premium on the new shares issued last year, together with the interest which had been already received on these investments. Interest and compound interest invested, and he hoped some additions to the principal, would bring these funds to a very respectable sum in due time. The property which they had lately acquired in Eccleston-place and in Millbank street adjoined their works, and would, when needed, be adapted for them. It was absolutely necessary to be possessed of this land before they stood in immediate need of it, otherwise the owners would raise the price against them.

Mr. Edmund Boulnois, M.P., seconded the motion, which was unanimously adopted, and subsequent resolutions followed authorising a dividend at the rate of 9 per cent. per annum for the half-year, which, with the previous dividend, makes 7 per cent. for the year.

The retiring directors were then re-elected, and, on the motion of **Sir Mark Stuart, M.P.**, seconded by **Mr. Stratton Boulnois**, the Board of Trade auditor was appointed the auditor for the Company.

INDIA RUBBER, GUTTA PERCHA AND TELEGRAPH WORKS COMPANY, LIMITED.

The ordinary general meeting of the shareholders was held at the Cannon-street Hotel on Thursday morning, Mr. S. W. Silver presiding.

The **Chairman**, in moving the adoption of the report, which recommended the payment of a dividend of 15s. per share, congratulated the shareholders on the results of the year's operations. They had passed through a period of many changes not the least affecting their trade, which was greatly improved. The works, having been kept prepared and ready, were in a condition to meet any demands made upon them. The electrical department had been fully employed in erecting installations for important cities, including Brussels, which was considerably extending and increasing its demand upon them. They had manufactured and laid about 300 miles of submarine cable for the Cuban Telegraph Company, and all the other cables turned out had been most satisfactory. The chairman concluded by referring to the death of Mr. Robert Henderson.

Mr. Scott seconded the adoption of the report.

Mr. Wright asked several questions as to items on the balance-sheet, but

The **Chairman** said they could not answer those questions, as they would be giving valuable information to be used against them by their competitors.

Mr. Silver and Mr. Scott were re-elected directors, and the auditors also were elected.

A vote of thanks to the Board concluded the meeting.

MAGDEBURG TRAMWAYS COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Tuesday, at Birmingham, to sanction the sale of the undertaking of the Company to the Union Elektricitäts-Gesellschaft on the terms of two agreements, dated May 27 and December 13 last. The terms entered into were that the purchase should be subject to the consent of the Town Council of Magdeburg to the transfer of the concessions, the amount of the purchase-money was to be £86,000 cash, to be paid on June 30 next, the tramways to be worked by the Company till that date for their own benefit, and the purchasers were to have the option of completing the purchase at earlier specified dates Inasmuch as the purchase included the Alte Neustadt Depôt, which the Company held on lease, with a purchasing clause at £8,300, it would be necessary for the Company to exercise that option, and therefore that sum must be deducted from the amount which would be available for distribution among the shareholders. The amount of the debenture debt, £25,000, must also be deducted, and assuming that the purchase was not completed before June 26, there would be £52,700 left for distribution, subject to the deduction of the necessary liquidation expenses.

Major Fosbery presided, and in proposing a resolution approving of the sale of the undertaking, said the Company was over-capitalised at the beginning, but the present directors were not responsible for the position of affairs, because they were not associated with the management until some time after the formation of the Company. The result of the sale would be that the shareholders would receive as nearly as possible £5. 10s. for each £10 share, and that was the best bargain the directors could make.

Mr. S. S. Lloyd seconded the resolution, and it was carried.

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Sir David L. Salomons, Bart. (chairman), the Earl of Suffolk and Berkshire, Edward Lucas, Colonel B. H. Martindale, C.B., Frederick W. Reynolds. Frank Bailey, engineer to the Company. J. Cecil Bull, manager and secretary.

Abstract of report of the directors to be presented to the shareholders at the ordinary general meeting of the Company to be held at Winchester House, Old Broad street, E.C., on Friday, February 21, 1896, at 2.30 p.m.:

The expenditure on capital account during the year ended December 31, 1895, amounted to £138,456. 2s. 6d. Details of this outlay are given in the capital account. During the year the balance of £100,000 of the present authorised amount of £400,000

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5 per cent. debenture stock has been issued, and an official quotation for the same has been granted by the committee of the Stock Exchange.

Revenue.

The total revenue for the year was			£109,766 19 10
From which must be deducted the following items:			
Expenses of generation and distribution	£32,324 4 6		
Rents, rates, taxes, general charges, and allowances to consumers	17,004 8 9		
Amount written off suspense account	1,338 0 8		
		50,666 13 11	
Leaving a net revenue of		59,100 5 11	
To which must be added the balance brought forward from 1894		752 13 11	
Making a total available revenue of		59,852 19 10	
Of this sum the following amounts have been distributed:			
(*a*) Interest on debenture stock for year ended December 31, 1895	12,076 16 0		
(*b*) Interim dividend on £400,000 6 per cent. preference shares, half-year to June 30 last	12,000 0 0		
		24,076 16 0	
Leaving for further distribution		£35,776 3 10	

The directors now recommend the following dividends—viz.: 6s. per share on the preference shares for the second half year, making with the interim dividend already paid a total distribution of 12s. per share, or 6 per cent. for the year, and 10s. per share on the ordinary shares for the year, being at the rate of 5 per cent. per annum. This will absorb £32,000, leaving a balance of £3,776. 3s. 10d., which the directors propose to carry forward. The necessary provision for depreciation in accordance with the City of London Electric Lighting Act, 1893, has been made. The generation and distribution expenses for the year, including repairs and renewals, were 36·87 per cent. of the earnings, as compared with 46 for 1894 and 54·2 for 1893. The Company continues to make satisfactory progress, the number of customers and lamps connected at December 31, 1895, being 4,230 and 195,317 respectively. On February 5, 1896, there were 201,128 8-c p. lamps (equivalent) connected, and, in addition, 8,759 awaiting connection. The income as shown in the audited statements of accounts issued by the Company for the year ended December 31, 1895, was as follows: gross revenue, £106 999. 17s. 2d.; net revenue available for interest and dividends, £59,100. 5s. 11d. In September last Mr. Joseph Bevan Braithwaite jun., resigned his seat on the Board. In accordance with the articles of association two of the directors, Lord Suffolk and Mr. Fredk W. Reynolds, now retire, and, being eligible, offer themselves for re-election. Messrs. W. H Pannell and Co. retire, and, being eligible, offer themselves for re-election. The total of the Company on capital account now stands at £1,127,910. 2s. 4d.

REVENUE ACCOUNT FOR 12 MONTHS ENDED DEC. 31, 1895.

Dr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Generation of electricity—		
Coal and other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on works	2,908 6 0	12,754 10 3
Oil, waste, and engine-room stores	262 5 11	986 5 0
Water	293 14 8	1,015 17 7
Salaries of station engineers and assistants	485 19 1	1,393 1 5
Wages and gratuities at generating stations	1,520 9 10	4,361 1 4
Sundry expenditure	23 12 9	123 3 8
Repairs and renewals as follows—		
* Buildings, £330. 19s. 3d; boilers, heaters, etc., £1,068. 6s. 2d.; engines and condensers, £1,224. 13s. 3d.; dynamos and exciter, £619. 12s. 8d.; other machinery, instruments, and tools, £565. 8s. 4d.—£3,478. 0s. 5d.		
Total generation expenses	£5,494 8 3	£20,633 19 2
Distribution of electricity—		
Proportion of salaries of engineer's assistants	175 13 2	256 1 9
Wages and gratuities to linesmen, fitters, and trimmers of lamps	1,368 3 6	305 2 10
Wages and gratuities to transformer men	—	1,690 4 10
*Repairs, maintenance, and renewals of mains, lamp posts, and transformers £3,222 6 6		
Carbons and other materials for street and other lamps	928 14 2	163 12 11
Sundry expenditure	—	29 12 11
Proportion of salaries of engineer and assistants, as adopted by Board and approved by auditors	298 6 7	980 4 4
Total for generation and distribution	8,265 5 8	24,058 18 10
Proportion of rents, rates, and taxes—		
Rents payable	782 7 2	2,347 1 7
Rates, taxes, and lighting	1,269 6 10	3,808 0 5
Proportion of management expenses—		
Directors' remuneration, salaries of manager, secretary, accountant, clerks, collectors, etc.	967 1 9	2,901 5 2
Printing and stationery	139 1 11	417 5 11
General establishment charges, including meter reading	135 19 11	407 19 11
Auditors' fees	18 7 6	55 2 6
Trustees' fees	26 5 0	78 15 0
Legal charges	31 11 6	94 14 6
Special charges—		
Allowances, deductions to consumers, and fines	136 17 2	2,630 5 6
Bad debts	—	348 7 1
Official testing of meters	—	8 2 6
Insurances	100 2 6	300 7 5
Total expenditure	11,872 6 11	37,456 6 4
Balance, being revenue for period carried to net revenue account	1,021 8 0	56,970 11 7
	£12,893 14 11	£94,426 17 11

Cr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Sale of current	—	91,282 14 5
Revenue under contracts	12,819 8 5	—
Meter rentals	—	2,623 18 0
Rents receivable	14 5 10	100 0 8
Transfer fees	18 12 10	130 9 8
Testing fees and sundry receipts	41 7 10	289 15 2
Total income	£12,893 14 11	£94,426 17 11

*These amounts and also the statutory depreciation have been provided out of the depreciation reserve fund.

GENERAL BALANCE-SHEET AS AT DEC. 31, 1895.

Dr. Liabilities, etc.		£ s. d.
Capital account		1,167,838 0 0
Sundry tradesmen and others, due on construction of plant, machinery, fuel, stores, etc.		26,407 18 8
Sundry creditors on open accounts		3,208 2 4
Sundry deposits—Consumers	£317 2 8	
Others	1,000 0 0	
		1,317 2 8
Depreciation reserve funds—No. 1	18,782 10 8	
Do. do. No. 1A.	4 456 18 11	
Do. do. No. 2	11,224 19 3	
Reserve fund	4 783 15 3	
		39,248 4 1
Balance of premiums on issue of £400,000 debenture stock and dividends thereon	79,030 11 10	
Less (*a*) expenses in connection with issue November, 1895, of debenture stock written off, £1,827. 4s. 3d; (*b*) transferred to depreciation reserve fund, £10 000; (*c*) transferred to reserve fund, £2,351. 3s. 6d.	14,178 7 9	
		64 852 4 1
Net revenue account—Balance at credit thereof	47,776 3 10	
Less interim dividend on £400,000 preference shares to June 30, 1895	12,000 0 0	
Balance available for distribution as proposed in report		35,776 3 10
		£1,338,647 15 8

Note.—Under existing contracts relating to the equipment of the stations and other works, there are further liabilities which become payable as the work progresses, subject to acceptance by and certificates from the engineer.

Cr. CAPITAL EXPENDITURE AND ASSETS.	£ s. d
Capital expenditure	1,127,910 2
Stores at stations and elsewhere	28,165 12
Sundry debtors for current supplied—September, 1895, £225. 1s. 3d.; December, 1895, £46,584. 17s. 8d.	46,809 18 11
Other debtors	12,208 16 11
Suspense account, £9,366. 4s. 11d.; less written off out of revenue, £1,338. 0s. 8d.	8,028 4 3
Cash at bankers and on hand—Deposit account, £35,000; current account, £21,301. 15s.; on hand, £20. 15s. 10d.	56,322 10 10
Sundry deposits and interest accrued thereon	3,252 19 1
Investments against depreciation and reserve funds—(*a*) £40,533. 6s., 2¾ per cent. consols at about 98 7/8 per cent., and three months' dividend accrued thereon, £40,269. 7s. 6d.; (*b*) £16,489. 1s. 3d., 2½ per cent. Metropolitan Consolidated Stock at cost, £15,680. 3s. 8d.	55,949 11 2
	£1,338,647 15 8

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HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED.

Directors: Henry Ramié Beeton (chairman), William Page (managing director), William Reginald Davies, Robert Arthur Germaine, William Francis Leese. Manager: Henry W. Bowden. Secretary: Thos. J. Owens.

Abstract of the report of the directors and accounts for the year ended December 31, 1895:

The revenue account shows a credit balance of £6,840. 16s. 1d., which, with the balance of £108. 11s. 5d. brought forward from the previous year, and £49. 11s. 8d., being dividend on 300 £5 fully-paid ordinary shares in the Yorkshire House-to-House Company, Limited, together with £12. 10s. 5d. for interest on deposit at bank, makes a total of £7,011. 9s. 7d. After deducting £1,907. 18s. 4d. for interest on debenture stock paid and accrued and other interest, and £875 for interim dividend paid on the 7 per cent. cumulative preference shares, the directors recommend that the sum remaining—viz., £4,228. 11s. 3d.—be dealt with as follows: in reduction of preliminary expenses, £500; to credit of depreciation account, £2,000; to payment of the remainder of dividend to December 31, 1895, on the 7 per cent. cumulative preference shares, £875; in reduction of the construction business development account, £788. 11s. 11d.; and that the balance of £64 19s. 4d. be carried forward to the next account—total, £4,228. 11s. 3d. The amount of £829. 9s. 4d. received as premiums on the issue of £10,000 debenture stock it is proposed to apply in further reduction of the construction business development account, thus reducing that item to £15,000. The increase in the lights connected during 1895 was equivalent to 8,304 8-c.p. (35-watt) lamps, being the largest increase since the year 1890, and the increase in revenue was £1,699. 5s. 3d, while the working expenses show an increase of £1,122 4s. 2d. During the year various alterations and additions to the plant have been made, which, it is anticipated, will tend to reduce the cost per unit of electricity in the future; but the effect of carrying out these works, while maintaining continuous running of plant, has naturally tended to increase the works cost for the period under review. A sum of £18,532. 8s. 9d has been expended during the year on additional plant, mains, and buildings and the expenditure for 1896 to meet the increased demand is estimated at £15,000. In order to provide for this outlay a further issue of capital is necessary. With regard to the construction business development account, the directors regret that they have been advised that the accounts of the Leeds and London Electrical Engineering Company, Limited (to whom this business has been leased), do not admit of the distribution of any profit. During the year 1895, a further £10,000 of 4½ per cent. mortgage debenture stock has been issued, bringing up the total issue to £50,000, being the full amount created. Mr. W. R Davies and Mr. R A. Germaine retire from the Board by rotation, and, being eligible, offer themselves for re-election. Messrs. Miall, Wilkins, Randall, and Co., the auditors of the Company, offer themselves for re election.

General Balance-Sheet, Dec. 31, 1895.

Dr.	£	s.	d.
Amounts received on account of issue of £50,000 4½ per cent. debenture stock	49,820	0	0
Sundry creditors on open accounts and for debenture interest accrued	8,964	18	4
Premiums on the issue of £10,000 4½ per cent. debenture stock	829	9	4
Doubtful debts reserve account	234	10	5
Depreciation account—provision against depreciation of leasehold buildings and other expenditure	4,400	0	0
Net revenue account, balance at credit thereof	939	19	4
Capital—8,322 ordinary shares of £5 each £41,610 0 0			
100 founders' shares of £5 each 500 0 0			
5,000 preference shares of £5 each 25,000 0 0			
	67,110	0	0
	£132,298	17	5

Cr.	£	s.	d.
Capital account—amount expended for works	102,380	8	7
Stores on hand at December 31, 1895: coal, £194. 12s. 2d.; oil, waste, etc., £145. 19s.; general, £149. 9s. 6d.	490	0	8
Sundry debtors for electricity supplied to Dec. 31, 1895	6,287	8	2
Other debtors, prepaid charges and suspense debtor	514	10	9
Cash at bankers—Messrs. Glyn, Mills, Currie, and Co., £102. 13s. 8d.; Parr's Banking Company and the Alliance Bank, Limited, £2,336 2s. 6d.	2,438	16	2
Cash in hand	39	3	6
Preliminary, debenture, and preference share issue expenses and foundation of business account—as per last balance-sheet, £3,958. 14s. 10d.; expenses of issue of 4½ per cent. debenture stock, £110. 5s. 5d.; less written off, £500	3,569	0	3
Construction business development account—as per last balance-sheet, £16,618. 1s. 3d.; less written off, £788. 11s. 11d.	15,829	9	4
150 £5 fully-paid ordinary shares of the Yorkshire House-to House Electricity Company, Limited, at cost	750	0	0
	£132,298	17	5

Revenue Account for the Year ended Dec. 31, 1895.

Dr.	£	s.	d.	£	s.	d.
To Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	3,276	10	7			
Oil, waste, water, and engine-room stores	630	9	11			
Proportion of salaries of manager and superintendents	478	11	0			
Wages and gratuities at generating station	1,274	16	7			
Repairs and maintenance as follows: buildings, £98. 16s. 7d.; engines and boilers, £212. 7s. 2d.; dynamos, exciters, motors, etc., £59. 16s. 6d.; other machinery, instruments, and tools, £64. 0s. 1d.	435	0	4			
Cartage of ashes	36	5	0			
				6,131	13	5
To Distribution of Electricity.						
Proportion of salaries of manager and engineers	39	14	0			
Wages	79	11	9			
Repairs and maintenance of mains of all classes	60	0	5			
Repairs, maintenance, and renewals of transformers, meters, and other apparatus on consumers' premises	59	6	11			
				238	13	1
To Rents, Rates, and Taxes.						
Rents payable	284	12	7			
Rates and taxes	224	4	1			
				508	16	8
To Management Expenses.						
Directors' remuneration, £1,500; less amount waived, £1,100	400	0	0			
Managing director's remuneration	150	0	0			
Salaries of secretary and clerks	305	9	6			
Collector's salary	102	10	0			
Stationery and printing	72	6	4			
General establishment charges	178	9	8			
Auditors of Company	26	5	0			
Auditors of the Board of Trade	26	16	9			
				1,261	17	3
Law charges				61	8	6
Insurances				80	11	11
Remuneration to trustees of debenture bondholders for 1889-1894, £500; less amount waived, £250	250	0	0			
Remuneration to trustees of debenture stockholders for 1895	21	0	0			
				271	0	0
				8,554	0	10
Balance carried to net revenue account				6,840	16	1
				£15,394	16	11

Cr.	£	s.	d.
Sale of electricity per meter at 8d. per B.T.U. (less discounts)	14,382	12	9
Sale of electricity per meter at 5d. per B.T.U. for cooking, heating, etc.	7	1	3
Rental of meters and other apparatus on consumers' premises	881	10	7
Transfer fees, £24. 12s. 6d.; students' instruction, £98. 19s. 10d.	123	12	4
	£15,394	16	11

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION, LIMITED.

Directors: G. H. Brougham Glasier, Esq., 7, St. James's-street, S.W. (chairman); Richard Chadwick, Esq., 34, St. Martin's-lane, W.C.; I. P. Mendoza, Esq., 4A, King-street, St. James's, S.W.; Agostino Gatti, Esq., and Stefano Gatti, Esq. (managing directors). General manager and secretary: E. Wilmot Seale, Esq. Chief engineer: W. H. Patchell, A.M.I.C.E., M.I.E.E.

Report of the directors to be presented to the ordinary general meeting of the shareholders to be held at 2, Craig's-court, Charing Cross, W.C., on Monday, February 24, at 12 noon:

The directors, in submitting the accounts for the year ended December 31, 1895, are glad to be able to put before the shareholders a satisfactory report of the working of the Company. There has been a constant increase in the demand for current, while on December 31, 1894, the Company were supplying energy to 41,216 8 c.p. lamps, they were on December 31, 1895, supplying to 51,302 8-c.p. lamps, being an increase of nearly 25 per cent. ever those supplied in that year, and 48½ per cent. over those supplied in the year 1893. The station has been maintained in a high state of efficiency, but the directors have thought it well to carry £3,000 to depreciation account. The provisional order enabling the Corporation to supply electricity in the district of the Strand District Board of Works was granted by the Board of Trade, and the Bill confirming it passed a Committee of the House of Lords; owing, however, to the dissolution of Parliament, the Bill

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could not be dealt with by the House of Commons, by whom it will be considered in the present session of Parliament. In view of the large increase in the business of the Corporation, a wharf and spacious premises, covering an area of 29,000 square feet, have been secured in the Commercial-road, Lambeth. The necessary alterations to render the premises suitable for an electric lighting station are now being made, and trunk mains laid connecting up the proposed station with the existing station of the Corporation at Maiden-lane. The net earnings, as shown in the revenue account, have amounted to £12,587. 3s. 11d.; £700 has been written off for preliminary expenses; £300 from law costs suspense account; £3,262. 10s. has been paid in respect of interest on debentures up to December 31, 1895; and £2,899. 18s 10d. was distributed in payment of an interim dividend at the rate of 4 per cent. for the half-year ended June 30, 1895. A sum of £5,424 15s. 1d. now remains, which, added to the undivided profit of £304. 19s. 10d. from last year's account, makes £5,729 14s. 11d, and which the directors propose to deal with as follows: to pay a dividend (less tax) at the rate of £6 per cent for the half-year ended December 31, 1895, making with the interim dividend paid in August, 1895 £5 per cent. per annum for the whole year, £4,350. 1s 2d.; and to carry forward, £1,379. 13s. 9d. Mr. Stefano Gatti and Mr. Richard Chadwick are the directors who retire by rotation and, being eligible, offer themselves for re election. The auditors, Messrs. O. R. Johnson and Son, also retire and offer themselves for re-election.

REVENUE ACCOUNT FOR YEAR ENDING DEC. 31, 1895

Dr.			£	s.	d
To Generation of Electricity.					
Coal or other fuel, including carriage, etc.	£5,194	5 9			
Oil, waste, water, and engine-room stores	454	3 8			
Proportion of salaries of engineers, superintendents, and officers	370	3 7			
Wages and gratuities at generating stations	1,665	1 1			
Repairs and maintenance as follows: buildings, £126. 1s 3d.; engines, boilers, dynamos, motors and other machinery, instruments, and tools, £1,517. 2s. 7d.; accumulators and accessories, £52	1,695	3 10			
Clearing away ashes	84	0 0			
			9,462	17	11
To Distribution of Electricity.					
Proportion of salaries of superintendents and officers	501	15 3			
Wages and gratuities to linesmen, fitters, labourers	371	17 6			
Repairs, maintenance, and renewals of mains of all classes, including materials, and laying the same	233	17 8			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	32	6 4			
Wayleaves and licenses	18	11 0			
			1,158	7	9
Royalties, etc., payable for use of patents or patent processes			57	13	3
Rates and taxes			510	12	1
To Management Expenses.					
Directors' remuneration, salaries of general manager and secretary, accountants, clerks, and messengers	1,225	3 3			
Stationery and printing	88	16 3			
General establishment charges	181	14 9			
Auditors of Company	52	10 0			
Auditor appointed under the provisions of the Order, 1894	48	17 0			
			1,597	1	3
Law expenses			45	5	0
Depreciation in respect of leasehold premises, buildings, plant, machinery, etc.			3,000	0	0
To Special Charges					
Insurances	99	8 3			
Interest on loan	33	6 8			
Compensation for injury	19	4 0			
			151	18	11
Total expenditure			15,983	16	2
Balance carried to net revenue			12,587	3	11
			£28,571	0	1

Cr.	£	s.	d.	£	s.	d.
Sale of current per meter	27,745	3	11			
Sale under contracts	114	0	0			
				27,859	3	11
Rentals of motors and other apparatus on consumers' premises				347	11	9
Rents receivable, less outgoings, in respect of the Company's house property not in its own occupation	231	13	8			
Transfer fees	9	17	6			
Discounts, etc.	122	13	3			
				364	4	5
				£28,571	0	1

GENERAL BALANCE SHEET, DEC. 31, 1895.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	220,000	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., to December 31, 1895	4,773	1	11
Sundry creditors for debenture interest to December 31, 1895	1,633	13	4
Net revenue account—balance at credit thereof £8,629 13 9; Less interim dividend paid thereout in August, 1895 2,899 18 10	5,729	14	11
Depreciation fund account	5,300	0	0
	£237,436	10	2

Cr. Assets.	£	s.	d
Capital account—amount expended for works	219,031	18	4
Estimated minimum value of fully-paid shares taken in satisfaction of bad debt	32	0	0
Purchase of premises not used by the Company, including law charges in connection therewith	5,136	3	3
Outlay on Lambeth work, to date	1,115	4	8
Stores on hand at December 31, 1895: coal, £81. 18s.; oils, waste, etc, £13 6s. 9d.; general, £136. 15s.	231	19	9
Sundry debtors for current supplied to December 31, 1895	10 834	15	9
Other debtors	122	10	0
Suspense account—law costs	622	12	0
Cash at bankers and in hand	309	6	5
	£237,436	10	2

NATIONAL TELEPHONE COMPANY, LIMITED.

The report of this Company for the last six months of 1895 states that the income amounted to £422,649, as compared with £378,789 for the corresponding period of 1894 an increase of £43,860. The working expenses were £216,537, as compared with £205,192, an increase of £11 344. The net result, after deducting the Post Office royalties, amounting to £38,238, is a profit balance of £167,874, as compared with £138,643, an increase of £29,231. The rentals carried forward for unexpired terms of running contracts amount to £354,635, as compared with £313 979, or an increase of £40 656. Out of the available balance of £138,217 the Board recommend the payment of a dividend at the rate of 6 per cent. per annum less income tax, on the first and second preference shares, 5 per cent. per annum, less tax, on the third preference shares and 6 per cent. per annum, free of tax, on the ordinary shares. The Board also propose to transfer £35,000 to the reserve fund, and to carry forward the balance of £6,623. With regard to the preliminary agreement for the acquisition by the Post Office of the Company's trunk lines, it is stated that the many difficult questions involved in the settlement have led to some further delay. Happily, however, the amount due to the Company is now practically agreed, and there is reason to believe it will very soon be paid. In the meantime the Board is loyally co-operating with the Post Office in preparing for that transition in the conduct of the trunk business of the country which will follow the assumption of the trunk lines by the State.

NOTTING HILL ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: William Crookes, Esq., F.R.S. (chairman); Arthur Ellis Franklin, Esq.; Alexander Howden, Esq.; James Thomas Jervis, Esq; Francis Radford, Esq.; Sidney Waters, Esq. Engineer and manager: G. Schultz. Secretary: R. G Rawkins.

Report of the directors and abstract of accounts to be submitted to the shareholders at the ninth ordinary general meeting to be held at the offices of the Company at Bulmer-place, Notting Hill, on Tuesday, February 25, at 5.30 p.m.:

The expenditure on capital account at the date of the last balance-sheet stood at £78 335 16s. 1d. During the past year a further sum of £5,702. 18s. has been expended. The largest item is for an additional battery of accumulators, which has been rendered necessary by the expanding business of the Company, and the balance is principally for mains in Addison-road and for other extensions. The required capital has been raised by the issue of ordinary preference shares, and owing to an increased demand for these shares, the directors have been able to obtain a premium of £2 a share in recent allotments. The amount of premiums thus obtained—viz, £246—has been applied to the reduction of the preliminary expenses account. The whole of the remaining unissued shares, amounting to £11,380, have been applied for at the same premium, and when allotted the directors will be enable to apply the premiums realised (£2,276) to the further reduction of this account. The revenue account shows a profit of £3 227. 14s. 10d., as compared with profits of £2,101. 17s. 8d. in 1894; £1,481. 7s. 1d. in 1893; £112. 6s. 1d. in 1892; and a loss of £554. 18s 6d. in 1891. The number of lamps on the circuit has increased from 15,669 to 20,307, being an increase of 4,688 lights, against increases of 3,516 in 1894, 2,715 in 1893, and 3,382 in 1892. The amount received from the sale of current shows an increase of £1,686. 12s. 2d., following an increase of £687. 4s. last year, and has now reached a total of £5,881. 0s. 10d. The expenditure on repairs and maintenance has been £780. 3s. 3d.,

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an increase of about £270 over last year. This increase arises from special additions which might have been charged against the depreciation reserve: the whole of this amount was, nevertheless, paid out of revenue. The sum of £700 has been set aside for depreciation and renewals, making up this fund to £1 300, and after writing 3 per cent. off the preliminary expenses and allowing for the other items on the net revenue account, a balance remains of £2 329. 9s. The directors recommend the following dividends: (1) 6 per cent. less income tax on the ordinary preference shares for the year ending December 31, 1895, £901. 17s. 2d.; (2) 2 per cent. free of income tax on the ordinary shares, £1,290. 8s.; carrying forward the balance of £137. 3s. 10d. In their last report the directors explained the position of their application to Parliament for powers of supply over the northern part of Kensington. The provisional order from the Board of Trade was duly obtained, and the confirming Bill brought into Parliament, but unfortunately it had not passed through its final stages at the time of the recent dissolution, and it will therefore be proceeded with again during the present session, no opposition being anticipated. The engineer and manager, whose valuable services have before been referred to by the directors, reports that the machinery, plant, and mains are in good condition, and no accident of any kind has occurred The directors who retire are Messrs. William Crookes and Sidney Waters, and, being eligible, they offer themselves for re-election. The shareholders' auditors, Messrs. Fox, Sissons, and Co., retire, and, being eligible, they offer themselves for re election.

Dr. General Balance Sheet, Dec. 31, 1895.	£	s.	d.
Capital account—amount received	87,085	0	0
Sundry tradesmen and others, due on contracts for fuel, stores, etc, to December 31, 1895	920	17	6
Sundry creditors	1,131	2	11
Depreciation and renewal fund account	1,300	0	0
Net revenue account—balance at credit thereof, £2 329. 9s., less interim dividend paid on ordinary preference shares, £406. 12s.	1,992	17	0
	£92,359	17	5

Cr.	£	s.	d.
Capital account—amount expended for works, including cost of provisional order	83,998	14	1
Sundry debtors for current supplied, etc., to December 31, 1895	2,579	9	1
Other debtors	30	10	0
Stores on hand at December 31, 1895—lamps, £37. 2s. 11d; meters, £229. 4s. 8d.; coal, £32. 18s. 2d.; general, £349. 13s. 5d.	648	19	2
Stock (movable plant and tools)	242	0	10
Cash at bankers—Parr's Banking Company and the Alliance Bank, Limited, Notting Hill, £195. 18s. 2d.; cash in hand, £12. 13s. 4d.	208	11	6
Preliminary expenses, compensation, etc., £5,049. 2s. 2d.; less 3 per cent. written off, £151. 9s. 5d; promiums received on issue of 123 ordinary preference shares (£2 per share) £246—£397. 9s 5d.	4,651	12	9
	£92,359	17	5

Revenue Account for the Year ending Dec. 31, 1895.

To Generation of Electricity.

Dr.	£	s.	d.	£	s.	d.
Coal and other fuel, including dues, carriage, etc.	601	3	3			
Oil, waste, water, and engine-room stores	102	6	11			
Wages and gratuities at generating station	362	8	11			
Repairs and maintenance, as follows—(1) buildings, £59. 17s. 10d.; (2) engines, boilers, £130. 3s.; (3) dynamos, £17. 8s. 4d.; (4) other machinery, instruments, and tools, £51. 6s. 9d.; (5) accumulators, £386. 0s. 11d.	644	16	10			
				1,710	15	11
To Distribution of Electricity.						
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same				135	6	5
Rates and taxes				297	4	0
To Management Expenses.						
Directors' remuneration	400	0	0			
Salaries of engineer and manager, secretary, clerks, and messengers	694	4	10			
Stationery and printing	44	9	6			
General establishment charges	74	19	5			
Auditors of Company	31	10	0			
Auditor appointed by the Board of Trade under the provisions of the order	25	10	0			
				1,270	13	9
Law expenses				23	11	0
To Special Charges.						
Insurances	48	1	10			
Rent of wayleave	5	0	0			
				53	1	10
Connecting installations and sundry stores				221	19	4
Balance carried to net revenue account				3,227	14	10
				£6,940	7	1

Cr.	£	s.	d.
Sale of current per meter (183,327 units), less discounts and after providing for bad debts	5,881	0	10
Rental of meters and other apparatus on consumers' premises	321	18	10
Connecting installations, sale of stores, etc.	461	14	10
Rents receivable	265	15	1
Transfer fees, etc.	9	17	6
	£6,940	7	1

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Parma (Italy).—The municipal authorities of the city of Parma desire tenders by February 25 for the electric lighting of the city from June, 1897, to 1912.

Namur.—Tenders will be received on July 10 next for the construction of a telephone building at Namur. Plans and particulars can be obtained from le Service Téléphonique, Namur.

Leeds.—Firms desiring to tender for the various works required in extension of the electric light station in Leeds, should send their names to Messrs. Milnes and France, architects, 99, Swan-arcade, Bradford.

Teneriffe (Canary Islands).—Tenders are invited for the electric lighting of the town of Santa Cruz, Teneriffe, for a period of 35 years. Particulars can be obtained at the Ministerio de la Gobernacion, Madrid, and tenders must be delivered by February 29.

Elberfeld.—Tenders will be received on February 28 for the supply to the Prussian State Railways of iron wire, bronze gutta-percha-covered wire, insulators and supports, etc., for the telegraphic service. Address, Die Konigliche Eisenbahn-Direktion, Elberfeld.

Bangor.—Tenders are invited by the Corporation for the construction, supply, and laying down of the necessary plant and mains for the supply of electricity in the borough. Tenders are to be sent to the town clerk by March 18. Full particulars will be found in our advertising columns.

Brunn (Austria).—The Municipality desire offers for the construction and working of a central station for the supply of electric energy for lighting the town, for power, and, if required, for running a tramway. Tenders must be sent before March 31 to the Bürgermeister, Brünn, Austria, from whom particulars can be obtained.

Lisbon.—Tenders are wanted by the Royal Portuguese Railway Company for the supply of apparatus for electric alarm bells. Tenders, suitably endorsed, must be sent to the Chief Engineer, at the Company's Stores, Santa Apolonia, Lisbon, by March 11, and particulars, etc., can be obtained from the Paris Offices of the Company, at 28, Rue de Châteaudun.

Sunderland.—The Town Council ask for tenders for two continuous current dynamos and engines, three Babcock and Wilcox boilers, an economiser, and water-softening plant. Particulars can be obtained from the borough electrical engineer at the electrical supply station, Sunderland, upon depositing £1. 1s, and tenders must be in by March 13.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grange-town, Yorkshire, to whom the plans, etc., must be sent by May 1.

Hanover.—Tenders are wanted for the supply of anthracite coal to the amount of 2,250,000 kilogrammes (about 230,000 tons) during the year for the municipal electric supply station. Tenders for lots of 10,000 kilogrammes are to be sent in by February 29, and particulars can be obtained for 50pfg. (6d) from the Registratur, Stadtisches Elektricitätswerke, Hannover.

Keighley.—Tenders are invited for providing and fixing telephonic communication between the various buildings forming the infectious hospital now in course of erection at Morton Banks, near Keighley, for the Keighley and Bingley Joint Hospital Board. The buildings and plans can be inspected on application to Mr. Alfred Moore, clerk of the works at the hospital. Tenders, marked on the outside "Tender for Hospital Telephones," will be received by Mr. Geo. E. Spencer, clerk, North-street, Keighley, not later than noon on March 4.

Hanover.—Tenders are wanted for the supply to the State Railways during the ensuing year of certain articles for the telegraphic service of the districts of Altona, Cassel, Erfurt, Hanover, and Münster. The contract includes 250 lamp globes, 40,000 lamp chimneys 38,600 zincs and 22 500 coppers for galvanic batteries, 40,900 kilogrammes sulphate of copper, 5,040 kilogrammes sulphate of zinc, 159,700 rolls of paper-tape, etc. Conditions and particulars can be obtained from the Rechnungsbureau, Königliche Eisenbahn Direktion, Joachimstrasse, Hannover.

Cologne.—Tenders are invited for the supply of about 8,300 battery cells, 9,900 stoppers and glass funnels, 19,200 zincs, 11,720 coppers, a quantity of connections, 38,640 kilogrammes of sulphate of copper, 5,400 kilogrammes of sulphate of zinc, 8,100 bottles of ink, 316,500 rolls of paper-tape for the telegraphic service of the State Railways at Cologne, Elberfeld, Essen, Frankfort-on-the-Main, and St. Johann-Saarbrücken (44 lots).

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Particulars and conditions can be obtained for 80pfg. (10d.) from the Königliche Eisenbahn Direktion, Centralbureau, Domhof Nr. 28, Köln a. Rh., and tenders must be in by February 29

Chesterton (Cambs).—The Urban District Council is open to receive tenders for the public lighting of the district for seven years. The tenders shall be made in the three following modes—namely, (*a*) lighting the district from August 14 to May 15 (inclusive) in each year; (*b*) lighting the district throughout the whole year commencing May 15 next; (*c*) lighting the district for either of the above periods (1) with ordinary burners, (2) with incandescent burners, if the illuminant with which the tender be made be gas. All cleaning, lighting, and maintenance to be done by the contractors. Tenders to be sent to Mr. James Spearing, clerk, 15, Sydney-street, Cambridge, by 28th inst.

Islington (London).—The Vestry of St. Mary, Islington, invite tenders for electrical engineers' stores, etc. Forms of tender and further particulars may be obtained, and the draft contract inspected by application, between 10 a.m. and 12 noon, at the Vestry Hall, Upper-street, N. No tender will be received after 12 noon on 27th inst. Persons tendering must be prepared with a £10 note, to be deposited (not enclosed with the tender), as a guarantee of good faith until the execution of the contract. Those tendering for more than one of the items must enclose each tender in a separate cover, and be prepared to deposit a separate £10 note with each tender. Each cover must be properly endorsed.

Tunbridge Wells.—Tenders are wanted for the enlargement of the central electric lighting station, adjoining the South-Eastern Railway goods station, at Tunbridge Wells, for the Corporation, to be carried out under the superintendence and in accordance with drawings prepared by the borough surveyor, Mr. T. E. W. Mellor, A.M.I.C.E. The drawings and specification may be inspected at the office of the borough surveyor, town hall. Persons wishing to tender may obtain bills of quantities on application to Mr. W. C. Cripps, town clerk, Town Hall, Tunbridge Wells, accompanied by a fee of £2. 2s., which fee will be returned on receipt of a bona fide tender. The person or firm whose tender is accepted will be required to enter into a formal contract and a bond with two approved sureties for the performance of contract. Sealed tenders, endorsed "Electric Light Station," must be sent to the town clerk by 25th inst.

RESULTS OF TENDERS.

Liverpool.—The tender of Messrs. Craven Bros, Manchester, £65, has been accepted for erecting an overhead travelling crane in the engine-house at Aubrey-street, for the City Council.

Taunton.—The Electric Lighting Committee have received tenders for the supply of 1,000 tons of steam coal, and accepted that of Messrs W. Thomas and Co. for Powell Duffryn best large steam at 14s. 4d. per ton, delivered at the works, a weight note to be delivered with each load at an extra cost of 2d. per ton.

Harrogate.—The following tenders have been accepted for the works required in the erection of electricity generating station on the Corporation farm, near Harrogate, for the Corporation. Mr. Samuel Stead, borough surveyor:

J. Stephenson, Florence House, Oatlands Mount, Harrogate, mason, etc.	£2,747	18	0
G. A. Carrick, Little Wonder, Harrogate, joiner, etc.	240	0	0
G. A. Terry, 3, Holderness-terrace, King's-road, Leeds, painter	26	17	9
T. Rayner, 35, Franklin-road, Harrogate, slater	83	5	3

Swadlincote.—The following were the tenders received for lighting the township of Stanton with electric light, for the Swadlincote Urban District Council. Mr. R. Cartwright, Swadlincote, surveyor:

Hall and Geary, Church Gresley, near Burton-on-Trent (accepted)	£120	0	0
Fletcher, Hirst, and Co., Burnley	117	0	0
Cutting Bro., Derby	119	0	0
Electric Construction Company, Limited, Wolverhampton	145	0	0
Walsall Electrical Company, Limited, Walsall	151	0	0
Ellis and Ward, Birmingham	179	0	0
H. M. Edwards, Cardigan Works, Wakefield	186	10	0

BUSINESS NOTES.

Ross.—There are at present about 400 navvies employed at the aluminium works at Foyers.

Liverpool.—At the new Dingle Station of the Overhead Electric Railway a shed is to be erected for the stabling of bicycles.

Southend.—Messrs. Crompton and Co., of Chelmsford, estimate the cost of the additional plant for lighting the town by electricity at £2,900.

Portobello (Midlothian).—The Town Council have appointed a committee to consider and report as to introducing the electric light into the burgh.

Neston.—The electric light is being installed at Ashfield Hall by Mr. J. S. Harmood Banner. The installation will be of a very elaborate character.

Portsmouth.—The Town Council have decided to light Goldsmith avenue with 28 electric lights (incandescent), and run mains through, at a cost of £1,500.

Peterborough.—The Town Council have decided to apply to the Local Government Board for sanction to borrow £20,000 for the electric lighting of the city.

Radcliffe (Lancs.).—The Urban Council have resolved that the compulsory area for electric lighting purposes be a limit of 200 yards from the main trunk line.

Southport.—The telephone has proved of great service throughout the Corporation departments, but intercommunication is needed between the Southport and the Birkdale police systems.

Bury St Edmunds.—In view of the Corporation's proposal for an electric lighting scheme, the gas company at their general meeting considered the question of introducing improved incandescent gas lamps.

Brush Company, Limited.—Notice has been given that the first debenture stock transfer books of the Brush Electrical Engineering Company, Limited, will be closed from February 19 to March 3, 1896, both inclusive.

The Furness Railway.—The directors have decided to light experimentally two of the main-line passenger trains with Stone's system of electric lighting, in place of the unsatisfactory system of lighting by oil lamps.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending February 16 amounted to £1,134, as compared with £843 in the corresponding week of the previous year, being an increase of £291.

Harrogate.—The borough surveyor has laid before the General Purposes Committee draft specifications which he had prepared for the works in connection with the electric light buildings, and after revision they were approved.

Leeds.—The Tramways Committee of the Corporation were to have visited Bristol on Monday to inspect the electric tramway, but the visit had to be deferred to meet the convenience of those who were to receive the deputation.

Newcastle-on-Tyne.—The poll of the ratepayers upon the tramways question, which was demanded at the town's meeting on January 15 last, commenced on Saturday and closed on Wednesday. The counting begins to-day (Friday).

Leeds.—At the Municipal Offices Messrs. Hopper and Sons offered for sale by auction electric lighting plant, engines, and boilers, put in by the Leeds Corporation about six years ago at a cost of £5,000 The amount realised was £1,684. 2s. 6d.

South Africa.—Messrs. Meldrum Bros., of Manchester, have received instructions to equip the new electric supply works of Johannesburg with their patent forced-draught furnaces, and the Durban electric supply works are to be similarly equipped.

Cardiff.—Mr. Hallett has reported as to the allegations made in connection with the electrical department. He suggested several alterations in the staff, and said there was nothing serious the matter with the machinery. The Corporation have adopted the report.

Telegraphic Material.—The Customs House returns show that during January last the value of the exports of telegraphic wires and apparatus connected therewith was £57,224. For the same month in 1895 and 1894 the amounts were respectively £35,193 and £18,738.

Northampton.—The electric light company report that, after allowing £250 for depreciation, there is sufficient, and a small balance over, to pay 1½ years' interest up to last June on preference shares. A dividend to ordinary shareholders thus is thought to be within measurable distance.

Coatbridge.—At a meeting of the Town Council, Councillor O'Neil gave notice of motion for the appointment of a committee to consider the advisableness of the Town Council acquiring the works of the gas company and the electric lighting company, with a view to working these in the public interest.

Obituary.—We hear with regret of the death of Mr. John A. Bird, the managing director of Rose and Bird, Limited, which took place after a very brief illness on Thursday, 13th inst. We are informed that arrangements have been made so that the business of the company shall be carried on as usual.

Aberdeen.—After the successful experiment with the lighting of their carriages by electricity, the Great North of Scotland Company have now permanently introduced the system in their suburban trains between Aberdeen and Dyce. The new illuminant is regarded as a great improvement on the old method.

Hampstead (London).—The Lighting Committee have reported to the Vestry that they had instructed the vestry clerk to prepare a full report on the electric lighting undertaking to the end of the year 1895. A fund has been opened on behalf of the parents of Edwin Clarkson, the victim of the recent fatal accident.

City and South London Railway.—The returns for the week ended February 16 were £949, compared with £998 for the corresponding period of last year, being a decrease of £49. The total receipts for the half-year terminating as above were £6,946, compared with £7,039 in the same period of the preceding year, being a decrease of £93.

Tramways Union.—The report of this company, to be presented at the annual general meeting on the 25th inst., refers to the circular on electrical traction addressed to the shareholders last July, and adds that the directors are glad to be in a position to report that considerable progress has been made towards obtaining the necessary powers therein alluded to.

Coventry.—Last week some excitement was caused at Coventry by a breakdown in connection with the electric tramways. A car had passed a junction of the overhead wires about two-thirds of the way down Hertford-street, when some sparks were seen flashing from the trolley wire, which shortly afterwards fell. The car stopped suddenly. The wire for some length fell to the ground.

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Buralem.—At a meeting of the Wolstanton Rural District Council to consider the proposal of the North Staffordshire Tramway Company to extend their lines into the district of the Council, it was unanimously decided to agree to the proposed extensions from Longport to Wolstanton and from Sandyford to Golden-hill, subject to a time limit being fixed by the Board of Trade.

Metropolitan Asylums Board.—It has been determined to invite tenders for the provision of telephonic communication and electric bells and fire alarms at the Brook Hospital, and the Fountain Hospital Committee reported the acceptance of an estimate, at the sum of £59. 7s. 4d, from the Private Wire and Telephone Installation Company, to make good the defects in the electric bell system.

Huddersfield—At a meeting of the Tramways Committee it was stated that no further communication had been received from the London and Provincial Electric Traction Company, Limited, who made overtures to the Corporation for a lease of the tramways. The Local Government Board have granted the Corporation authority to borrow £50,000 for electric lighting. The Town Council have agreed to the extension of the tramways.

Belfast.—A deputation of the Town Council has visited Dublin and Bristol to examine into the question of electric tramways. Havre, Paris, Brussels, and Berlin are also to be visited by the deputation. Mr. A. Hamilton Smythe, C.E., appointed by the Board of Public Works in Ireland, has held an enquiry concerning the proposed street tramways. Mr. Nance (assistant borough surveyor) stated that the total length of the proposed double lines was 6 miles 7 furlong 8·6 chains.

Lochee (Forfarshire).—The electric light, which has been fitted throughout the baths and library, is generated by a dynamo which has been placed over the drying-chamber in the laundry, and which is capable of working up to 50 amperes. The power is obtained from the engine which drives the laundry machinery. A main switchboard has been fitted convenient for the attendant, and from this control of the whole installation is had. Messrs. James Maxwell and Son have carried out the work. This is the first public installation of the electric light in Lochee.

Prestwich—At the meeting of the Urban District Council a report was presented on the electric lighting of the district, which set forth that by an outlay of about £5 000 a reasonable profit would be made provided not less than 6,000 lights were used; but it would not be wise for the Council to proceed further in the matter until it had been ascertained whether it was likely that this number of lights would be used. With a view to obtaining this information it was recommended that circulars be issued to the residents and ratepayers. The report was adopted.

Dublin.—The Corporation have had under consideration two proposals for introducing the principles of electric traction into the street-car traffic of the city. The South District Tramway Company, which has an electric line on the outskirts of the city from Balls Bridge to Kingstown, but no footing inside the city, proposed an extensive scheme, and of this, on the advice of the city engineer, 13 miles were approved at a rental of £4,000 per annum, the rental to be revised every five years. By 21 votes to 17 the overhead trolley system of electric traction was approved.

Ayr.—A report by the electrical engineer, submitted at the meeting of the Council, recommended that additional plant be got. Mr. R. M. Beveridge held that the Council were being made toys of in connection with the electric light. He held that there had been bungling, and that the time had come when they were not going to sit by with their fingers in their mouth. This electric light held the Town Council up to contempt to the inhabitants and visitors to the town. Mr. Park, the electrical engineer, thought the light for dwellings would be ready in the first week of March.

Morecambe.—At a meeting of the District Council Mr W. R. Brown produced a catalogue of articles to be sold at the electric works, and asked whether it would be advisable to appoint someone to purchase articles which would be of use to the Council Mr. J. Brown replied that the engineer appointed by the Council had valued everything that would be useful to them, and the things to be offered for sale would be of no use to the Council. The seal of the Board was affixed to the agreement between the Council and the electric light company on the motion of Messrs. J. Brown and W. Harper.

Hull.—At a meeting of the Electric Lighting Committee Mr. Skinner, deputy chairman, moved, "That this committee regrets the retirement of the late chairman from the committee, and they take this opportunity of expressing their appreciation of the services rendered by him to the town in the establishment of the now successful electric lighting station." Mr. Atkinson seconded the motion which was carried unanimously. Mr. Atkinson moved, and Dr. Kessen seconded, that Mr. Skinner be appointed chairman of the committee. The motion was carried unanimously. Mr. Millington was elected deputy chairman.

Torquay.—According to the latest modifications of the electric lighting scheme, it is stated that it is proposed to utilise cellars adjoining the Bath Saloons as a generating station The whole of the sea-front from the Bath Saloons to near the railway station is to be lighted by electricity. Fleet street is also to be lighted, and Union-street, from the Strand to Tor Station. The 70 arc lamps necessary for this are estimated to cost £1,260. For private lighting, mains are to be laid in the following roads: Happaway-hill, Warberry-road, Torwood-street, Meadfoot-road, Babbacombe-road, Higher Erith-road, and Lower Lincombe-road.

Catalogue.—We have received a catalogue and price-list (Section A) from Messrs. P. R. Jackson and Co., Limited, steel and iron founders, millwrights and electrical engineers, of Manchester. Numerous photographs are published of the works at Salford Rolling Mills, and also of the machinery, patterns, castings, etc., and a useful and complete price-list is appended. This firm has been very successful in its new electrical department, and, in addition to a large number of dynamos for electric lighting and the transmission of power in mines and mills, there are on order eight large dynamos of 270 kilowatts each.

The Isle of Man Tramways.—The Isle of Man Electric Tramway Company have issued a notice to the shareholders stating that the Company intended to apply for sanction at an extraordinary general meeting to purchase the Snaefell Mountain Railway for £72,500, the purchase-money to be payable £32,500 in cash, £20,000 fully-paid 6 per cent. preference shares, and £20,000 ordinary shares. The Company is asked to increase the capital to £175,000 by the creation of 25 000 new £1 preference shares. The Company's system will then extend 12 miles from Victoria Pier to the summit of the Manx Monarch Mountain.

Bradford.—The sub committee of the Gas and Electricity Committee have met to consider matters relating to the new electricity works They decided to entrust to Messrs. John Brown and Co., Limited, of Sheffield, the construction of the new boilers, fans, and some other machinery for the new works. It being reported to the committee that the Board of Trade had sanctioned the increased voltage recently referred to, the committee gave instructions for the preparation of estimates of the cost of the extension of the supply of light along Manningham-lane as far as Queen's-road, with the view of proceeding with such an extension if the applications are numerous enough to justify the expenditure.

Willenhall.—At a meeting of the Urban Council, the General Purposes Committee reported that they had considered the application and position of the fire brigade, and they recommended that no more than £70 be spent in providing electric calls from such station to the residences of the firemen. Councillor Tayler moved that the recommendations be adopted, and Councillor Knowles seconded. Councillor Parkes said he could not vote for the amount for electric calls. He was in sympathy with the brigade, but possibly during the next six or twelve months they might have to remove their stores to a more suitable place. The report was adopted, no member voting against it.

Warminster.—At the Urban Council meeting the Clerk said he had received a letter from Mr. Toone offering to supply the necessary electric current for lighting the arc lamp on the fountain He had made a calculation that the lamp would be lighted 1,640 hours, and the previous contract was ridiculously low, and Mr. Hill must have been considerably out of pocket by the transaction. On the Council laying down the cable, maintaining the lamp, and renewing the carbons, he would light the lamp from sunset to 11.15 p.m. and from 6 a.m. to sunrise each day, except Sundays, for £24 per annum. The matter was referred to the Sewage and Electric Light Committee for consideration and report.

Darjiling (India).—Mr. Mitchell, of the firm of Messrs. F. Osler and Co., Calcutta, has visited the Rungli Khola and Little Rungneet Rivers with the purpose of discovering a means of water power to work turbines for electric lights for the town. He observed that the water-flow at Rungli Khola was not sufficient to work a turbine capable of lighting the town with electricity, but that the Little Rungneet would be better suited to fulfil the work. The spot selected is near Sidrapong. It is proposed to start the generating power there and to conduct the current to the town, a distance of about three miles.

Halifax.—There was a large attendance of members of the Town Council on the occasion of their visit last week to the electricity works, Foundry-street, to witness the starting of No. 4 engine, which has been supplied by Messrs. Pollit and Wigzell, Sowerby Bridge, at a cost of about £3,000. It is a vertical compound-condensing engine, with a speed of 140 revolutions per minute and a stroke of 2ft. 6in. The engine is 600 h.p., and is fitted with Corliss valves. It is directly coupled to a 300 kilowatt alternator, the machine being built round the flywheel. The Mayor started the engine, and afterwards, at the invitation of Alderman Woodhead, the company adjourned to the offices, where refreshments were served.

J. D. F. Andrews and Co.—We are informed that Mr. J. D. F. Andrews has severed his connection with the firm hitherto carried on, under the name of J. D. F. Andrews and Co., at 34 Victoria-street, and has started in business on his own account under the same name (J. D. F. Andrews and Co) by Putney Bridge Station, London, S.W. Mr. J. D. F. Andrews has made some improvements in his system of concentric wiring. These relate more especially to a new wire which he has devised for the system, for the manufacture of which he is setting up plant at Putney Bridge Station. The new wire is neat in appearance, and is sufficiently stiff to be fixed to a wall in perfectly straight lines. The outer conductor is a copper tube, and the insulation is fire resisting.

Worcester.—The Street-Lighting Arc Lamp Sub-Committee have recommended an extension of the arc lamp lighting by the provision of further lamps in College-street, Sidbury, Bridge-street, the Bridge, St. Nicholas-street, and Lowesmoor. This would entail capital outlay of £1,850 for laying down mains, etc., and the lighting would cost £650. or for less than three times the cost of the gas-lamps, the Council would have 20 times as much light. At £650 per annum 26 lamps would displace 74 gas-lamps, of which 55 were double burners, lighted at a cost of £222 per annum. This extension would require four new circuits, and the

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mains would be of sufficient sectional area to allow of future extensions. The gas-lamps to be displaced had an aggregate candle-power of about 1 600.

London Extensions.—Notice under Electric Lighting Acts and Orders having been given by the County of London and Brush Provincial Electric Lighting Company of intention to construct two large transformer boxes, the one at Field-place, St. John-street-road, and the other at Peartree-court, the committee of the London County Council recommended this should be sanctioned subject to the condition that there shall be no gas-pipe within such distance from any box as is equal in feet to the diameter of the gas-pipes in inches, and that adequate means be taken to prevent the accumulation of gas in the boxes and conduits. Notices were also passed from the Vestry of St. Pancras of intention to lay mains across Camden-road; in Gray's-inn-road, Wells street, and Phœnix-place; and to lay a lead-covered cable in stoneware casing in Judd-street.

Edinburgh.—The members of the Edinburgh Architectural Association were conducted over the electric lighting station at Torphichen-street last week under the guidance of Mr. Monkhouse, the resident engineer. On assembling in the engine-room Mr Monkhouse made a short statement regarding the machinery, its capacity, and the intentions of the Electric Lighting Committee regarding an extension of power. In reference to the expenses incurred in opposing a claim made by the company possessing the electric lighting patent of Dr. Hopkinson, which would expire in July next, for a renewal of the patent, it was stated in the Town Council that, should the company be successful in this point and in proving that Edinburgh had adopted the patent, the Corporation might be mulcted in an annual rental of £700, increasing on extensions, for 14 years.

Fareham.—The District Council have obtained the consent of the Local Government Board to the raising of a loan of £6,681 for the purchase of the electric light undertaking, the laying of electric lines underground, the purchase of lamp columns and an additional engine, and the cost of an additional adviser. The central body has, however, refused to sanction the borrowing of £200 for the purchase of additional land, and of £120 for larger wire for the underground lines; but it is thought that sanction will not be withheld in these respects when a little further explanation is given. The District Council have resolved upon coming to a speedy settlement forthwith, subject to the approval of the Board of Trade, and have decided to engage an electrical engineer to advise them in the matter. Mr. E. Manville, if willing to act, is to be invited to state his terms.

Taunton.—The Town Council have decided to increase the salary of the borough electrical engineer (Mr. Couzens) by £50 per annum. The electrical engineer reported as follows: "We have laid the main to Staplegrove for the supply of Pinkhurst, and we are now commencing to test the same. The cables and plant for No. 3 transforming sub-centre are in hand, and will be laid shortly. As regards the other mains, I have gone into the matter very carefully with Dr. Fleming, and these will be laid of adequate capacity, and in such a way as to meet the probable future requirements of the district which they serve. Since writing my last report we have fixed the new engine and alternator, and are running the plant regularly. Dr. Fleming made an inspection of this extension and the works generally on December 4 last, and reported to the committee thereon."

Bristol.—After discussion the Electric Lighting Committee have decided to recommend to the Town Council that no objection should be raised to the tramways company using electric traction on the tramway to Fishponds-road and supplying the current from their present station at St. George, on condition that any future proposal for the adoption of electric traction in other parts of the city must be on the principle of the current being supplied by the Corporation. The committee express the opinion that, having regard to the large outlay of capital undertaken by the Corporation to enable them to supply electricity for all purposes and to the fact that they are prepared to undertake such supply, all future applications for extension of electric traction within the city should only be entertained upon the condition that the electricity be supplied by the Corporation.

Bath.—The City Council have again had before them the question of the electric lighting of the city and the respective applications of the Council and the electric lighting company to the Board of Trade for a provisional order. The company are anxious to obtain a provisional order for 40 years and to extend the lighting area, but the Council want to have the electric lighting of the city under their own control and are applying for the provisional order themselves The committee in their report asked that they might be allowed to proceed upon the basis of the advice of Mr. Hammond, their consulting engineer, who, in an exhaustive report to the Council, recently specified what portion of the company's plant might be acquired in the public interests The report was adopted without discussion, as it was thought unwise to go into the details of the negotiations in public.

Harwich.—At the Town Council's quarterly meeting the Public Health Committee reported that they had exhaustively considered the tender of the Towns and Villages Electric Lighting Company for the supply of an installation of electricity for public and private lighting, but the company having withdrawn their offer to purchase the rights of the Corporation under the Harwich (Corporation) Electric Lighting Order, 1892, they recommended that the negotiations be terminated. The Mayor said the company gave them to understand from their tender that they were going to supply the plant, etc, but had declined now to do so. The initial outlay for such plant, etc., would mean a great expense to the borough, and he (the mayor) thought the Council were justified in retracting from what the Council did on November 9. Several members concurred, and the recommendation of the committee was unanimously adopted.

Yarmouth.—At the meeting of the Town Council the surveyor reported that since the last meeting applications had been received from five new customers for 155 lamps making the total number of customers 145 for 6,647 lamps In addition to the applications named above, there was one on the North-quay requiring a considerable extension of the mains. The income for the past month was £284. 6s. 8d.; the expenditure amounted to £149. 19s. 7d.; earned beyond cost of production, £134. 7s. 1d. The repayment of capital, interest, rates, and insurances now amounted to about £100 per month. The surveyor was instructed to ascertain whether there are likely to be any additional customers upon the North quay. Messrs. Turrell and Torkildsen made application for and obtained leave to lay the electric light into the office at 23, South quay, which they hire of the Corporation.

London County Council.—On Tuesday the Parliamentary Committee reported as follows: "By the United Tramways Provisional Order it is sought to exempt the company from the provisions of the London Overhead Wires Act, 1891, and the by-laws made under the Act, and to authorise the company, with the consent of the Council to place overhead wires for working the tramways by electrical or other mechanical power, including the overhead trolley system of electric traction or any other system. The Council twice last year refused its consent to the use by this company of electric traction by means of overhead wires, and, having been informed by the Highways Committee that in their opinion the granting of the order should be opposed, we recommend that the Council do refuse its consent to a provisional order being granted to the London United Tramways Company." This was agreed to.

Dewsbury.—Speaking on the motion for the adoption of the Lighting Committee's report at the Town Council, the Mayor said that, so far as the electric light of the town was concerned, they seemed at present to be in a fair way of securing some return for the outlay made. For instance, he found that last week there was a result of £40 to the good. He did not mean to say that there would be such a return for every week in the year. More electricity was being required; and since the beginning of November there had been a gradual increase in the consumption. Councillor Wilby said he had been informed by a member of the Council that, in the storing of electricity, there was a loss of something like 47 per cent. Was there any truth in that? The Mayor said there was a loss, and they would remember that the committee had ordered a new engine and dynamo, and as soon as they had obtained it they would be able to do away with the loss.

Llandrindod Wells.—It having transpired since the last meeting of the Urban District Council that Mr. Edward Davies, J.P., of Llandinam, was prepared to form a company to provide an installation of the electric light, and would undertake to light the public lamps (32 c.p) at 40s. per annum, against 58s. 6d. under the hitherto proposed contract, and private lights at 6d. per unit, against 7d. and 8d. under the contract, after a heated debate, it was resolved to inform the contractors with whom negotiations had been going on (Messrs. Jevons and Thomas) that the Council were not now prepared to proceed with the proposed contract Although the standing orders prevented any definite decision being arrived at as to the alternative scheme, it was agreed that Mr. Edward Davies's order should be accepted at the next meeting, and Mr. Davies subsequently attended the meeting and arranged for the immediate completion of the business, so that the street-lighting may be installed by next August.

Wakefield.—At the City Council meeting Councillor Cradock was added as a member of the Electric Lighting Committee. Councillor Moorhouse remarked that he hoped now that the committee was complete no time would be lost in calling it together. He believed it had only been once called together since the 9th of November, and in the present position of affairs he thought this was an unfortunate delay. Alderman Sherwood, chairman of the committee, said, in answer to Councillor Moorhouse, that there was very little to meet about at the present moment, for the simple reason that they were waiting for the order of the Local Government Board sanctioning the borrowing of the money. Councillor Moorhouse said it was not information, but customers that they wanted now. The new County Council offices are to be supplied with the electric light from the Corporation's works about to be constructed at Calder Vale, upon which the sum of £25,000 has to be expended.

Lynn.—At a meeting of the Town Council the Town Clerk said when the original notice was given for the electric lighting provisional order a little clause was overlooked, and it was now necessary to confirm it. Mr. Savage said he understood that the cost would not be more than £50, but the other day he found that the cost would be £200 at least, and some said it might be £400. If up to the present they had only spent £100 he thought they had better drop it altogether. The Town Clerk said he asked his parliamentary agents what the cost would probably be and they said £200, and he mentioned that at that time. Up to the present four-fifths of the expense had been already incurred. Mr. Floyd pointed out the necessity for going forward, or they cleared the way for a private company to step in, which they would regret. Twenty municipal authorities had gone in for electric light and some of the results were very remarkable, while no serious loss had occurred even on the first year's working. It had been a financial as well as a lighting success. The order was confirmed.

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Maidstone.—At the Town Council meeting the Mayor moved that the consideration of the Electric Lighting Committee's report be deferred for another fortnight. He had received a requisition to call a town meeting to consider the electric lighting question, and on account of this he thought it was advisable they should postpone the consideration of the committee's report for another fortnight. Mr. Cox seconded the resolution. Alderman Ellis observed that the electric lighting question was getting rather old. It was 12 months ago that the Council instructed the committee to see if they could dispose of the order, and now that they had got a report recommending certain steps to be taken, it could not, for some reason or other, be discussed by the Council. If they would discuss the report, which had been dangling before them for the past month, there would probably be some reasons before the public meeting for the action which the Council had been taking in the matter. The resolution was carried.

Walsall.—The Baths Committee report read at the meeting of the Town Council contained a recommendation that the baths be lighted with the electric light, and that the tender of Messrs. Fellows and Wheatcroft for supplying and fixing the necessary fittings, in accordance with the specification prepared by the resident electrical engineer, for the sum of £120, be accepted. This was agreed to. The Electric Lighting Committee reported that the whole of the electric lighting plant continues to run in a satisfactory manner. The total number of consumers supplied on January 28, 1896, was 45, the number of units consumed during the four weeks ending that date being 5,230, and the income therefrom £130. 15s The length of mains laid is—low-tension, 2¼ miles; high-tension, 1¾ miles; pilot mains, 1¾ miles. The number of applications for supply received since January 31 is four. With the view to reduce the temperature in the Dragon Hotel transformer station, the committee had given instructions for the removal of the flue in connection with the heating apparatus to the Dragon Hotel Assembly Rooms to some more convenient position. The report was adopted.

Ashton-under-Lyne.—The Sanitary Committee have been requested by the Electric Lighting Committee to supply information relative to the erection of the refuse destructor, in order that the question of utilising the same in connection with the proposed electric light installation may be considered. The Highways and Tramways Committee reported at the Council meeting that the town clerk submitted a letter received on January 17 from the clerk of the County Council, in reference to the application *re* the Oldham, Ashton, Hyde and District Electric Tramways, asking for the views of the Corporation in respect to the provisions of the proposed provisional order enabling the promoters to place and maintain on any street or road posts and overhead electric wires for working the tramways. The town clerk was instructed to write in reply stating that the committee saw considerable objection to such posts and overhead wires, but expected, in the event of the application being proceeded with, to induce the promoters to erect such posts and wires on the most improved principles, and so that any objection thereto might be minimised as much as possible. The report was adopted.

Swansea.—The negotiations with the tramway company for the purchase of their undertaking have fallen through. It should be stated that this does not prevent the scheme of electric lighting and a dust destructor being carried out. Powers were obtained for electric lighting some years ago, and have not lapsed whilst the dust destructor is simply a question of public sanitation Sir John Jones Jenkins, M.P., was in communication with the Corporation on Tuesday on the subject concerning the points in dispute with the Swansea Tramway Company, and also, it is said, as to the possibility of acquiring electricity for driving the Mumbles trams. The letter from the tramway company was couched in the following terms: "60, Finsbury-pavement, London, E.C., February 17.—Swansea Tramways and Swansea Corporation.—Dear Sir,—I have submitted your letter to my clients, who are unable to alter their views as expressed in my letter of the 13th inst.—Yours truly, HUGH C. GODFREY.—To the Town Clerk, Swansea." On receipt of this letter the town clerk (Mr. John Thomas) wired instructions to his London agents at once to withdraw the Tramways Bill. It is stated that there is no possibility of the negotiations being reopened.

Whitehaven.—At the Town Council meeting the engineer reported as to progress made in laying new cable to Bransty, George-street, and Oakbank, and further correspondence between the engineer and Dr. Hopkinson. It was resolved that the engineer write to Dr. Hopkinson as soon as the repairs to the conductors were completed, and request him to come to Whitehaven and inspect and report to the committee on the whole system of conductors laid under Messrs. Siemens's contract. Further correspondence with Messrs. Hathorn, Davey, and Co. as to delivery of the new pumping engines was read, and the engineer reported on the progress which was being made in laying the new mains to Kells-cottages. Councillor Musgrave said it was apparent that there would be a necessity to relay the whole of the single-wire cable before the term of Messrs. Siemens's contract expired. They were about to lay a substituted cable to the end of the North Pier, and one from the Grand Hotel to the top of Bransty, joining the portion already relaid there The committee expected Dr. Hopkinson to be at Whitehaven within the next fortnight, when they hoped to have his advice as to the course they should adopt with regard to the remaining faulty cables not yet relaid.

Dover.—The following letter was read at the Town Council Managing Committee meeting from the Electricity Supply Company: "Regarding our offer of the 27th ult., to supply incandescent electric lighting in some of the streets along the lines of our mains, we now observe that it has been stated, and not contradicted in the Council, that the Corporation are in honour bound to complete the contract they are entering into with the gas company. Under these circumstances we do not feel inclined to press our claim. For the present we are content that the Council should know that we are prepared to offer the same advantages to the town as our friends the gas company, and at as low a price. As, however, the efficiency of electric lighting is daily becoming more manifest, we expect that we shall soon hear again from you on the subject In the meantime we feel that we have earned the sympathy of the ratepayers of Dover. The price of gas has fallen, and public lighting of the streets been immensely improved; we leave it to the burgesses of Dover to judge if they would have had these benefits but for the presence of this company." The committee thought this was a very satisfactory letter, and unanimously decided to recommend the Council to seal the contract with the gas company.

Plymouth.—Interesting experiments have been made on tramcars belonging to the Corporation and the Plymouth, Stonehouse, and Devonport Tramways Company, electricity being substituted for oil as a lighting power. Several members of the Tramways Committee and the managers of the private company rode in the cars, and at the end of each trip the prevailing opinion appeared to be that the present mode of lighting the cars was not to be compared with the electric lamps. The experiments were made at the instance of the I. E. S. Accumulator Company, Limited, who fitted the cars with the light in such a manner that the source of the power was invisible to the passenger, the wires being carried along the top of the cars. Two Edison-Swan lamps were placed at each end of the car usually occupied by lamps, the accumulator being placed under the seats. The light enabled passengers to read a newspaper when sitting at any part of the car, and was not affected in the slightest by jolting, whilst there was of course, an entire absence of the disagreeable smell produced by oil lamps. It is claimed that after the initial cost the light is as cheap as oil, and as the outer casing of the lamp needs removing not more than once a year, there is also a great saving in labour. Special advantages with extra lightness and durableness are claimed for the accumulators with which the trial was made.

Castleford.—The lighting of the town by gas leaves much to be desired, and the Urban District Council have at last taken the matter in hand. At the last meeting, Mr. Latchem moved, "That the clerk be instructed to acquire all the necessary materials for the purpose of applying to the Board of Trade for permission to procure a supply of electric light for public and private consumption." In doing this, Mr. Latchem said he thought he was expressing the feelings of a large number of people in the town. The price of gas had been higher and more excessive than it ought to have been, and all the ratepayers of the town knew that the quality of the gas had been but very poor indeed. The matter had become a general complaint, and he thought a little consideration by the company was required. He was not going to reiterate what had been said at the previous meeting, but he must say that the matter had got to the extreme He had been a little surprised to find that towns further away from coalfields than Castleford paid a considerably lower price than they did. There was something wrong somewhere, and it was quite time the matter was taken up by the Council. He was aware some considerable time would have to elapse before they could have the better light installed, but if they got the order they could proceed at any convenient time to secure the much-needed remedy. On these grounds he moved the resolution. Mr. Wood seconded, but it was eventually decided to hold the subject over for another meeting, so as to have the matter well threshed out.

Kensington (London).—The Works Committee have reported to the Vestry that their attention had been called to the fact that a portion of the Fulham road has been opened by the Chelsea Electricity Supply Company, for the purpose of laying bitumen conduits for electric lighting mains without notice to the Vestry, the portion of roadway in question being situate in the parish of Chelsea, but maintained by Kensington under an arrangement with the Vestry of Chelsea. In reply to a letter addressed to them upon the subject by the surveyor, the company have signified their willingness to pay the cost of the restoration of the road, but the committee endorse the opinion of the surveyor, that works of this nature affecting the stability of a road maintainable by the Vestry should be carried out under their supervision; and the committee accordingly recommended that the vestry clerk be instructed to communicate with the company, intimating that the Vestry will object to any interference with roads under their control and management, without prior notice, and requiring them to take out a license before proceeding with the execution of any works. This recommendation was agreed to. The Works Committee further reported having had before them a letter from the Kensington and Knightsbridge Electric Lighting Company with reference to the Jandus arc lamp fixed as a trial on the refuge in Kensington High-street, by St Mary Abbott's Church, intimating that they would be willing to extend the trial, but expressing the opinion that the Vestry should pay them the cost which would have been incurred had the previous lighting been continued; and the committee recommended that the company be informed that the Vestry will be prepared to pay them the cost of the maintenance of an ordinary refuge lamp from February 4 and during the continuance of the trial of the Jandus arc lamp. This was also agreed to.

Glasgow.—The India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Glasgow, Bradford, and Silvertown, Essex, have secured the contract for a complete installation of electrical machinery for the Glasgow Subway Company, Limited.

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The contract includes four high-speed engines and dynamos, 13 electric power pumps, the lighting of 15 stations and trains, and the supply of power for the elevators. The current will be supplied from a central station in Scotland-street, and conveyed through tunnels by means of cables highly insulated with india-rubber. At a meeting of the Police Department of the Corporation, Mr. Primrose submitted the minutes of the Watching and Lighting Committee, which included the report, already published, on the electric lighting of the city streets. He dwelt upon the great superiority of the system adopted in Edinburgh compared with that of this city, and pointed out that its comparative cheapness was due to the policy which had from the first been pursued consistently and persistently by the Edinburgh Corporation of making popular the electric light. Mr. R. M. Mitchell was not prepared to accept fully the rosy report of the Edinburgh deputation, as important particulars on some points had been withheld—the fact, for instance, that the lamps were put out at 12 o'clock at night, while here they were kept burning all night. The cost of the light in various cities which he quoted led to him to believe that it was not so bad as it had been painted Dr. Colquhoun contended that the failure was due to the initial blunder of adopting the low instead of the high tension, in consequence of which two stations were necessary in place of one, and that in one the machinery and staff were kept idle all day. The report of the committee was adopted, and the matter remitted back to them to consider and report as to what measures are necessary to improve the system. In view of the report and adverse criticism by the Watching and Lighting Committee on the system of the electric lighting in Glasgow as compared with that successfully carried out in Edinburgh, a meeting of the sub-committee on electric lighting has been held to consider the position of matters. It was ultimately agreed to co-operate with the Watching and Lighting Committee with the view of devising means to improve the lighting.

Torquay.—At a special meeting of the Town Council the Electric Lighting Committee recommended that application be made to the Local Government Board for sanction to borrow £22,300 for the purpose of proceeding with the electric lighting of the borough. The committee also presented a report from Mr. W. H. Trentham, M.I.M.E., who estimated the cost of plant for 4,000 16-c.p. lamps and 70 arc lamps, with the proper reserve power, as follows: three boilers, including setting, £2,031; six engines, steam-piping, etc., £3 815; dynamos, exciters, accumulators, switchboard, etc, £4,320; 70 arc lamps and posts, £1,260; mains, transformers, street work, etc., £5,197; chimney, converting buildings, etc, £1,300; consumers' connections, meters, etc., £1.500; extension to Lincombe and Warberry districts, £2,147; contingencies and engineer's fee, £2,156—total, £23,716. The revenue per annum, charging the current at 6d. per unit, and taking the consumption at the very moderate rate of 13 units per 30 watt or 8-c.p lamp, would amount to £4 322, or, adding £519, the cost of gas lamps in roads, gardens and pier, where it is proposed to substitute arc lamps, the total revenue, with £150 for meter rents, would be £4,991. On the other hand, on the presumption that the destructor would give the power estimated—namely, 80 h.p.—the working expenses certainly should not exceed 2½d. per unit, which, including carbons for arc lamps and labour of trimming them, would be £3,234, or, adding interest and sinking fund, a total of £4,595, showing a net profit of £396. If, however, to be perfectly safe, they took the destructor as giving one-half the power above estimated, the working expenses, including interest and sinking fund as before, would be £4 895, clearly demonstrating that when the plant was fully loaded, they would get the light from the 70 arc lamps practically for nothing, even if the destructor would not perform what was claimed for it Alderman Kerswill, moving the adoption of the report, said the Council had already decided to retain the installation of electricity in their own hands. Therefore there would be no question in the future of paying something like 60 per cent. to buy back powers they had allowed to get into other hands. The lighting of the borough was already a big question and it would be greater in the future. The fact that some electrical companies were supplying boroughs with light at cost price should be a hint to gas companies to make an allowance to large consumers like the Corporation. Their provisional order had nearly expired, so they must now take action in the matter. Alderman Mortimer seconded, and the motion was carried by 14 votes to 4.

Belfast.—At the half-yearly meeting of the tramways company, the chairman referred to the contemplated use of electricity as a motive power for the tram system in Belfast. Electricity, he need hardly say, was fast coming to the front, and the tendency of all tramway companies was to alter their lines from a horse to an electric system. The fact was placed beyond doubt that in various cities on the Continent and in America the electric tram system was working in the most satisfactory manner. The directors, seeing what was taking place elsewhere, and what the general movement was in the tramway world, resolved to go carefully into the question. Having done so, they had deemed it advisable to deposit a Bill in Parliament taking powers to enable the company to apply electricity to the Belfast tramways. If they could not agree with the Corporation the Bill would be dropped, because the company had no desire to fight against the Corporation. In the event of both parties disagreeing, then this matter of electric tram power must be left over for a later period, when they would be more likely to see their way in adjusting their differences. He hoped, therefore, that the company on the one hand, and the Corporation on the other, would find no difficulty in coming to a settlement, in which event the Bill would be proceeded with this session. Mr. Wrigley asked if the directors had come to the conclusion that the electric system would be cheaper than the one now in use. The Chairman said the directors were certain that it would be cheaper; otherwise, he need hardly say, they would not have recommended its adoption. The directors had visited various places where electricity for working tramcars had been adopted. One of them (Mr. Murphy) had been to America, and he, with their secretary (Mr. Glenn) and their manager (Mr. Nance), had been to the Continent to acquaint themselves with the various systems. From all that they could learn, and from what had come within their observation, they had no doubt that the overhead system was the best to adopt. It was one of all others that would pay well, and it would effect a considerable saving over the working of the present system. These were the main considerations which weighed with them in recommending it for a city like Belfast. A special general meeting of the proprietors of the company was afterwards held, when the proposed Bill, entitled "A Bill to confer further powers upon the Belfast Street Tramways Company, and for other purposes," was submitted. The Chairman said that the meeting approved of the proposed Bill, and Mr. Fry seconded the motion. In replying to the questions, the Chairman said it was absolutely necessary to progress with the times, and they had to take into consideration the very manifest advantages which electricity had over horse power. With regard to the overhead system, the only difficulty which he apprehended against it was the presence of the supporting posts or poles *en route*. These, he pointed out, might easily be made of such an ornamental character as to deprive an objection of this kind of any force which otherwise it might possess Posts of this description would certainly be infinitely more desirable than the intolerable telephone and telegraph posts with which they were more or less acquainted. He did not think the Belfast people would, by reason of this objection, be greatly prejudiced against the electric tramway system. The motion for the Bill was agreed to. The Electric Committee have reported that the assistant engineer had attended and submitted applications for current supplies, some of which the committee were obliged to decline owing to the very great distance from the central station. They expressed the hope that within reasonable time the Corporation would establish a large generating station which would be capable of supplying the entire needs of the city.

Swansea.—A special meeting of the County Borough Council was held on Friday afternoon to receive the report of the last meeting of the Electrical Committee and the modifications offered by the committee to the tramway company in reply to their demands. The following letter from the solicitor to the company was discussed for two hours: "Your letter of the 10th inst has been carefully considered by my clients, who desire me to point out to you that the company has at no time shown any desire to depart from the original understanding as contained in the report of the Tramways Committee on October 31 and the letter from the secretary of the company of November 8 last. In the letter the secretary was careful to provide for 'the costs and other expenditure which must be incurred in carrying out the operation,' and which could not at that time, of course, be definitely defined, but particulars of which have since been given to the committee The company has no intention to apply any portion of the purchase-money towards return of capital to the shareholders, and will raise no objection to the application of the money being limited to the objects defined in the original proposal of the committee as modified by the letter of November 8 last Nor would there be any objection to agree that any portion of the purchase-money which should be left in the company's hands as working capital should be redeemed on the 21 years basis instead of 30. The company will also agree that any motors and cars provided by the Corporation shall be paid for on the 21 years' basis, provided that the company shall be at liberty to provide any of these cars if they elect so to do, in which case the cars would be the property of the company, and would be taken over by the Corporation on the same terms as the cars to be provided for the existing lines. The company cannot agree to pay for the cost of any plant necessary for the supply of the current, whether accumulators or transformers. They have no knowledge as to what the cost of these things may be, but it was agreed from the first that the current should be supplied to them ready for use and the price was fixed on this basis. I understand from your letter of the 6th inst. that the costs were to be divided between the Corporation and the company. The present proposal seems to be rather against my clients, although probably the difference may not be very great. With regard to the Mumbles Railway, there will be no objection whatever to the terms proposed, provided that the Corporation can make the arrangement which you suggest as feasible with the railway company. It seems to me, however, that this would more probably form the object of a separate agreement. It does not appear reasonable to the company that the purchase of the rolling-stock at the termination of the lease should be conditional on its being kept in a state of repair to the satisfaction of the borough surveyor. The rolling-stock is only to be taken at a valuation, and it is obvious therefore that the price will depend upon the condition of the material at the time of purchase. If however, the company should call upon the Corporation to provide any rolling-stock, the company would not object to the borough surveyor having power to call upon them to repair the same as and when required. If the committee should under the present circumstances recommend the Town Council to withdraw the Bill, the company, while regretting the result, will feel that they have done everything in their power to loyally carry out the understanding between themselves and the committee." The committee resolved to adhere to its recommendations, with the following variations: to alter the original

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expenses on which the £32,000 be expended, so that it can comprise (1) the purchase of cars and motors, (2) alterations of depôt, (3) payment of all reasonable costs incurred by the company in connection with this matter. Another variation was that all questions in dispute be subject to the arbitration of the Board of Trade, and another that the electricity supplied be measured from the transformer. It was decided that unless these terms as altered be accepted by Monday, when the Bill comes on for first reading, the Bill be withdrawn.

PROVISIONAL PATENTS, 1896

FEBRUARY 10.

2944. Improvements in electromagnetic instruments. Herbert Watson Sullivan, 29, Ladbroke square, London.

2964. An improved system of wiring for electric installations. Robert Cornelius Quin, 18, Hamilton-road, Brighton.

3022. Improvements in and relating to the electrodes of secondary batteries. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Hubert John Tudor, Belgium.)

3032. New or improved self-acting electrical signalling apparatus for preventing collisions on railways. Heinrich Otto Krapf, 115, Cannon-street, London (Complete specification.)

FEBRUARY 11.

3071. Improvements in and relating to dynamo-electric generator and motor collecting brushes. George Edenson Dorman, The Hawthorns, Newport-road, Stafford.

3082. Improvements in armatures for induction motors. Abe Lincoln Cushman, 52, Chancery-lane, London. (Complete specification.)

3083. An improved ceiling rose and attachment therefor, chiefly applicable for electrical purposes. Robert Walter Braham, 60, Red Lion street, Clerkenwell, London.

3091. Improvements relating to the composition of the filling paste of accumulator batteries. Richard Linde, 18, Buckingham-street, Strand, London. (Complete specification.)

3092. Improvements in controllers for electric motors. James Devonshire, 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.)

3093. Improvements in controllers for dynamo-electric machines. James Devonshire, 70, Chancery-lane, London. (Walter H. Knight and John W. Darley, jun., United States) (Complete specification.)

3094. Improvements in regulating phase relation of alternating currents. James Devonshire, 70, Chancery-lane, London. (Ernst J Berg, United States) (Complete specification.)

3096. Improvements in apparatus for regulating the tension of alternating electric currents. John Imray, 28, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la transmission de la force par L'electricité, France)

3133. Improvements in and relating to electric clocks. Jacob Wiesner and Albert Witzel, 6, Lord-street, Liverpool. (Complete specification.)

FEBRUARY 12

3151. Improvements in arc lamps. Annie Taylor Schmidt and Frederick Thomas Schmidt, 12, Cherry street, Birmingham.

3213. Improvements relating to treating or flashing filaments for electric incandescent lamps. John Hadden Douglas-Willan and Frank Eustace Wilkins Bowen, 24 Southampton-buildings, Chancery-lane, London.

3224. Improvements in or connected with culverts or conduits and insulators for carrying electric conductors, more especially intended for carrying underground bare electric conductors. William Harding Scott, 47, Lincoln's-inn-fields, London.

FEBRUARY 13.

3235. Improvements in electric cranes. Edward George Fiegehen, Stafford Lodge, Ampthill-road, Bedford.

3256. Improvements in electric cables. George Hinde Nisbett, 15, Water-street, Liverpool.

3322. Improvements in electric batteries. Josef Fuchs and Louis Thiemann, 18, Southampton-buildings, Chancery-lane, London.

FEBRUARY 14.

3350. Improvements in coin-freed apparatus for administering electricity. Karl Rudolph, 18, Southampton buildings, Chancery-lane, London.

3359. Improvements in electrical furnaces for volatilising metallic and other ores. Ernest Bailey and John Dunn, 10, Lorne-terrace, Maryhill Glasgow.

3361. The electro-plating of iron and other metals and alloys, and the electro-reduction of metallic iron. John Kirkwood, 2, Carson-street, Edinburgh

3375. Improvements in electrical contact devices for clocks and the like. Thomas Smith Paynter and George Crockroft Walker, 73, Wroughton-road, London,

3394. Improvements in electric glow lamps. George Webb, jun., and Leonard John Underwood, 77, Chancery-lane, London.

3409. Improvements in or connected with recording electric meters. Arthur Wright, Norfolk House, Norfolk street, London.

FEBRUARY 15

3441. Improvements in or connected with or to be used with telephones. James Hunter Bennet, 6, Lord-street, Liverpool.

3478. Improvements in switches for controlling glow or incandescent electric lamps when used in conjunction with arc lamps. William James Davy, 40, Chancery-lane, London.

3481. Improvements in dynamo-electric machines. Sebastian Ziani de Ferranti, 27, Charterhouse-square, London.

SPECIFICATIONS PUBLISHED

1890.

16889. Electric motors. Kennedy. (Second edition.)

1891.

584. Dynamo-electric motors. Hutin and Leblanc. (Second edition)

1894.

8961. Electro-chemical decomposition. Carmichael. (Second edition)

1895.

1698. Electric current regulators. H. and R. Niewerth.

2182. Incandescent electric lamps. Attree

3076. Telephone and telegraph systems. Lake. (Shea and another)

4352. Dynamo-electric machines and motors. Atkinson.

5875. Electric conduits. Muirhead.

6048. Electrical insulation. Bollé. (Jefferson.)

6075. Electric switches. Davy.

24098. Motor dynamos. De Puydt and Poncin

24354. Electric switches. Dorman and others.

24514. Holding electric lamps. Hacking and Bennett

24710. Lightning arresters. Devonshire. (Potter.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1-1½
—— Non. Cum., 6 per cent. Pref.	2	1⅜-1⅝
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅜-6½
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6⅜-7½
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	130-132
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10½-11
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2¼-2⅜
Edison and Swan United Ordinary	3	1⅝-2
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	⅞-1
—— 7 per cent. Cumulative Pref.	2	2-2⅛
Elmore's Copper Depositing	2	⅛-⅜
Elmore's Wire Company	2	¾-1
Fowler-Waring Cables	5	1-2
W. T. Henley's Telegraph Works, Ordinary	10	13¾-14½
—— 7 per cent. Preference	10	16-17
—— 4½ per cent. Debentures	100	109-112
House-to-House Company, Ordinary	5	3¾-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge Ordinary	5	7½-8
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅜-8⅛
Liverpool Overhead Railway	10	13⅛-13⅜
—— 5 per cent. Pref.	10	15½-16
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅜-⅝
Metropolitan Electric Supply	10	12-12½
—— 4½ per cent. First Mortgage Debenture Stock	100	115-118
National Telephone, Ordinary	5	6⅜-6⅝
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16-17
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6⅞
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	8½-9
Oriental, Limited, £1 shares	1	1⅛-2
—— £5 Shares	5	8½-8⅞
—— £4½ shares	4½	6⅞-7½
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	9-10
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	5⅜-5⅝
Westminster Electric Supply, Ordinary	5	9-9⅜
Yorkshire House-to-House	5	6⅜-7½

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NOTES.

City Technical Lectures.—Mr. W. H. Preece, C.B., is to be one of the lecturers in the Carpenters' Company's course of lectures on subjects connected with architecture and building at Carpenters' Hall.

Highbury Quadrant Association.—A lecture was given by Mr. P. P. Kipping, of the National Telephone Company, last Monday at Highbury-quadrant on the subject of the latest development of the telephone and telegraph.

Burmese Telegraphs.—Replying to a question of Mr. Yerburgh's in the House of Commons, Lord G. Hamilton said he had no information of an intention on the part of the Government of India to extend their Burmese telegraph system beyond its present terminus at Kieng Tung.

Finsbury Technical College.—A course of four lectures on "Recent Discoveries in Electro-Optics" is announced for delivery by Prof. Silvanus P. Thompson at the Technical College, Finsbury, on Thursday evenings in March. The lectures will deal with the experimental work of Hertz, Lodge, Tesla, Lenard, and Röntgen.

Iron and Steel Institute.—For the autumn meeting of the Iron and Steel Institute, which is to be held at Bilbao at the beginning of September, arrangements have been made to charter one of the Orient Company's steamers to convey the members there, and to act as a floating hotel. The cruise will last a fortnight. The annual meeting is fixed for May 7 at the Institute of Civil Engineers.

Theatrograph.—Mr. R. W. Paul's theatrograph is to be shown at the Royal Institution this (Friday) evening. The apparatus is one for the successive projection, by means of a lantern, of instantaneous photographs with such rapidity as to give an appearance of movement to the picture. The mechanism is so arranged that during the shifting of the picture the light is shut off. The apparatus is driven by a handwheel.

West Australian Telegrams.—The *Australian Mail* says that for more than a week Western Australia has been, so far as telegraphic communication is concerned, as quiet as the dead cities of the Zuyder Zee. Up to Tuesday nothing had been received since the 20th, and the news that came to hand then was despatched on the 18th. The interruption has been caused by storms and gales which have brought down the West Australian Government lines. Cablegrams, however, have now come to hand dated the 19th, so that communication is open again.

Tram-Wheels.—The February number of the *Street Railway Journal* sums up the recommendations which have appeared during the past year on the subject of electric tramway wheels. Our contemporary recommends a weight of 325lb. for a 33in. wheel. One wheel in every hundred should be tested for strength, and it should be specified that the wheels should be of uniform diameter within $\frac{1}{16}$in., and a guaranteed life of 40,000 miles should be demanded. Finally, flatting of wheels should be made an offence, leading to the prompt suspension of the motorman.

Motorcarts.—In his speech to the shareholders at the annual general meeting, the chairman of the Crystal Palace Company stated last week that it was intended to hold an international horse and horseless carriage exhibition, which would be of considerable magnitude. The grounds were well suited for experimental or competitive trials of the various kinds of motorcars, and the interior of the palace for a large show of carriages. The Lord Mayor had accepted the presidency of the honorary council, which also included the names of many noblemen and gentlemen of influence.

The Metric System.—Mr. W. M. Acworth has written to the *Times* pointing out that the Swiss Government have recently invited the countries parties to the Berne Convention—in other words, all the leading countries of the Continent of Europe—to a conference to discuss, *inter alia*, the introduction of a uniform gauge of screws based on the metric system. This is, according to the official document, intended to take the place of the Whitworth system, based on English measures, which is at present in use. Mr. Acworth points out that, if this is carried out, an obstacle due to our retention of a system different to the rest of Europe will be placed in the way of our foreign commerce.

A Chain Feeder Tramway.—A surface contact system for electric tramways has been described by Mr. Schnepf in the *Electric Railway Gazette*. In this system there is a chain lying in a trough covered by sectional rails, and under ordinary circumstances is not in contact with them. When, however, the car passes over the rail a magnet on the car draws the chain into contact with that particular section of the rail. The chain is connected to the feeders, and so makes that section alive while the car is passing over it. The sections are 8ft. long, and the rail is made of a non-magnetic metal. The chain is partly of iron and partly of brass. The commercial value of the system has not yet been demonstrated in practice.

Electro-Chemistry and Batteries.—According to the *Zeitschrift für Elektrochemie*, Liebenow's theory of electrolysis assumes that when a compound in solution can split up into ions simultaneously in different ways it will do so. In the case of the lead accumulator, owing to the low solubility of the lead salts and the low degree of dissociation of water, the lead ions and those from the water contribute little to the conductivity of the electrolyte, this being determined chiefly by the sulphuric acid. When a charging current flows through the accumulator only the peroxide and the lead ions in the solution will be set free, as they represent the least work of the current; but owing to their small number, they would soon be exhausted in the immediate neighbourhood of the electrodes, if the lead sulphate on the electrodes did not immediately go into solution after the deposition of these ions. When all the lead sulphate on one of the plates has been exhausted, a further current will electrolyse the water.

Technical Education.—The proposals of the Technical Education Board of the London County Council for the ensuing year involve a probable expenditure amounting to £120,000, of which £9,000 is for the equipment and £16,000 the maintenance of technical departments of polytechnics. The other items are £9,680 for Shoreditch, Wandsworth, and other technical schools; £20,000 for technical departments of public secondary day schools (including allowance for the fees of the Board's county scholars £7,500); £4,000 for higher education; £26,070 for county scholarships; £14,440 for art teaching (including art scholarships); and £8,985 for science teaching (including science exhibitions and pioneer lectures, technology, and manual instruction). In 1893-94 the Board's expenditure was £46,000; in 1894-95, £63,000; and in 1895-96, £91,000. One of the chief causes of the increase is the development of the Board's scholarship system, which has now nearly reached its limit, and is costing nearly £40,000 per annum.

New Incandescent Lamp.—A filament of somewhat complicated nature which it is proposed to use for incandescent lamps has been described in the German technical papers. The filament is made of hygroscopic asbestos paste. This, after being prepared in the form of a paper ·3mm. thick, is cut into strips 6cm. wide and impregnated with

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a 30 per cent. solution of platinum chloride, then passed through a saturated solution of sal-ammoniac, after which it is dried in hot air and then heated in a Bunsen flame, which converts the platinum solution into a platinum sponge. It is then further impregnated with a 20 per cent. solution of magnesium chloride and heated, which process is repeated until the plate is covered with a uniform coating of magnesia, and it is finally dipped into a 10 per cent. solution of cerite nitrate. The magnesium coating protects the platinum, and as the light-radiating properties of the cerite metals are much greater than those of carbon, it is thought possible that such lamps will take less current. It is stated that the electrical resistance is much higher than that of carbon, and the radiating surface can be made much greater.

A Radical Departure.—Inventors and others who have devoted their attention to working out new methods of electric traction have occasionally produced curious results, and it will probably be admitted that the system patented in the United States by Mr. T. F. O'Connor, of New York, is, as the *Electrical Age* puts it, "a radical departure in design and operation from any hitherto devised." In Mr. O'Connor's system there is a conduit, but every tramcar has its own conductor all to itself. This conductor is reeled out from the power-house to the tramcar, which drags it along the conduit over anti-friction rollers. It is remarked that on long lines "it will be necessary or at least desirable to divide the line into sections." (Few will dare to dispute this.) In that case, when the car has passed off the section and done with its conductor, the latter is dropped and hauled back from the power-house end. Various advantages are claimed for this remarkable system, but, curiously enough, no use is made of the fact that the tramcar cannot run away under any circumstances. It seems a pity to omit anything that could possibly be said in its favour.

Lighthouse Communication.—In the course of a lecture delivered at the Imperial Institute on Monday by Mr. Charles A. Kent, secretary of the Trinity House, on the subject of lighthouse illumination, it was remarked that telegraphic communication with light-vessels was now an accomplished fact, and the more difficult task of connecting rock lighthouses electrically was being dealt with, the non-continuous system which was in successful operation at the Fastnet lighthouse on the south-west coast of Ireland offering special facilities in this matter. With this system the difficulties formerly inseparable from carrying a telegraph cable up an exposed rock, where it was subject to constant chafing, were overcome, the cable now terminating in the water 60 yards off, and the electric currents sent from the shore finding their way through this distance to two bare wires that dipped into the sea from the rock. In connection with this it may be remarked that the Royal Commission on electrical communication with lighthouses will probably issue a fourth report in the course of the next few months, and hopes to be able to make its final report before the end of the year.

Quadruplex Telegraphy.—An article by Mr. W. Finn has appeared in the New York *Electrical Engineer* on the subject of the "K R" law as applied to quadruplex circuits. Innumerable attempts have been made in the past to improve the working of the quadruplex telegraph system, which is still far from being a perfect one, especially when operated upon long lines. This is because there has not yet been in use a receiving apparatus with a sufficiently low time-constant. The distance to which it is now possible to operate quadruplex successfully is limited by the capacity, K, and the resistance, R, of the line, and the number of signals that can be transmitted per second depends on the product, K R. The applicability of this law to the quadruplex system, however, has not been generally known or appreciated. Mr. Finn suggests that for each of the improved systems in use the value of K R should be found and serve as a standard for determining their working capacities and the distances. He made two such measurements, and concludes that it may be considered fully established that when the K R equals 10,500 it is an excellent working quadruplex circuit, and when it is equal to 35,938 it is an impracticable circuit for quadruplex working.

A Novel Ladder.—The *Elektrotechnischer Anzeiger* reproduces from a Tokio paper a diagram of a new kind of ladder adapted for telegraph and telephone poles. A detailed description is wanting, but it appears that the ladder is constructed upon the principle of the lazy-tongs, so that it will shut up into a small space, and can be easily carried out. When it is wanted it is pulled out, and cross-pieces rapidly fitted on to pegs so as to form a horizontal diagonal to each of the parallelograms of the lazy-tongs serve the purpose of steps, and at the same time render the structure rigid. Hooks are attached at the top to pass over the cross-piece of the telegraph mast. It is understood that the author of the design is Mr. S. Kanda, a professor in the School of Telegraphy at Tokio. From another source it appears that the particulars given in the Japanese paper the *Electrical Friend* describe the ladder as entirely constructed of hard oak. The length of the ladder varies from 12ft. to 18ft. when extended, and is only 2ft. when folded up. The thickness is about 3in., and the width about 1ft. The whole ladder could be put in a box of 600 cubic inches. Work of this kind is one of the Japanese strong points, and the contrivance may very possibly prove a useful one.

A Wire-Thief's End.—The following is taken from the columns of the New York *Electrical Engineer*: "While stealing fully-charged electric light wires in Newark a man named J. B. Gove received a shock while on a pole 25ft. above the sidewalk, and fell. His skull was fractured, and he died instantly. A companion engaged with him in the thefts disappeared. His identity is unknown. The two men were thoroughly equipped as linemen, and early in the night stopped with a horse and wagon, which contained a ladder, some tools, and a quantity of wire, in front of 298, Belleville-avenue. They took the ladder to a pole, and Gove ascended. He had cut one strand, and was working on another when he gave a cry, threw up his hands, and fell head foremost, landing on the block pavement. The other man ran to him, seemed to realise that he was dead, took Gove's watch from his pocket, jumped into the wagon, lashed the horse, and drove away before the astonished onlookers could interfere. A physician and policeman were summoned, and an examination showed that Gove's left hand had been badly burned by the wire. His skull was fractured, and his legs and other bones in his body were broken. It was learned that Gove formerly worked as a lineman in Atlantic City." No particulars are given as to the current or voltage. Up to the present it is believed that it has not been found necessary for companies in this country to take into calculation the danger of having their line stolen.

Lighting Drapers' Shops.—It has been pointed out in the *Drapers' Record* that more fires occur in drapery establishments than in any other class of business houses. It is not to be wondered at, therefore, that insurance companies are somewhat shy of taking such risks, even at increased premiums. With regard to minimising the fire risk incidental to a gas-lighted shop-window full of highly-inflammable materials, our contemporary refers to the practice of lighting the gas with an unguarded taper when

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a gas-lighting apparatus of a perfectly safe character is readily obtainable, and ought to be in universal use, and adds: "One of the greatest advantages of electric lighting has hitherto been supposed to be its freedom from dangers of this sort. The incandescent wires are completely covered by a glass case, and no taper is required for their ignition. These are advantages which it is impossible to gainsay, yet it is beginning to appear that they are not absolute but only comparative. Unless the fitting of the wires is thoroughly well done by experts, there is considerable danger of the fiery energy breaking out at unexpected and dangerous places. The only effectual way, therefore, to reduce the chances of fire to a minimum is to exercise the most scrupulous care in the choice of methods of lighting and their practical utilisation. We do not pretend to decide which is the best method under all circumstances, but certainly half-shielded gas-jets and quite naked tapers ought by this time to be things of the past."

Light Railways.—Mr. W. J. Brewer, in the course of a paper read at the Imperial Institute on the subject of light railways, held out the expectation that improvements would be forthcoming in rolling-stock and motive power to meet the requirements of feeder lines. By the aid of electricity it would be possible to supply both power and light, not only for the lines, but for the towns and villages on their route. The lines would be a means by which a system of telegraphs and telephones could be established at a slight expense, and they would add to the income. In his opinion, the new "autocar" in the interests of the agricultural classes would never do the work of a light railway, simply because no road could ever equal the surface of a rail. It was absurd to argue that these feeder lines should be of the same gauge as the main lines. The loads on the cars of the feeder lines could be so arranged as to be moved from the feeder car to the main-line car with the least possible amount of trouble or waste of time. As a motive power, Mr. Brewer took his stand by electricity. The materials comprising the car, motors, standards for carrying the electric conductors, rails, and other necessary equipment should be manufactured on the duplicating system, so as to reduce first cost and facilitate renewal. Points, crossings, signals, and signalmen could well be dispensed with, except at terminal stations. No greater mistake could be made than to load a light line by first initial cost. The speed he would suggest was from 10 to 12 miles an hour.

Forced Draught.—In the growing central station the question of increased boiler capacity is frequently a most troublesome one to deal with on account of limitations of space; and where the load line is particularly peaked, the solution of putting in more boiler power merely to carry the peak for a few hours is far from a satisfactory one, not only on account of the capital outlay and space occupied, but also because of the all-day decrease in economy of steam generation entailed. It is remarked by the *Electrical World* that the best solution, in many cases, is afforded by the storage battery, but a cheaper method consists of installing a fan and providing for forced draught. While with any air pressure increasing the capacity of the boiler plant to any significant extent there is a loss of efficiency in generating steam, yet as this would extend over but a comparatively short period, and the resultant efficiency may be greater than with natural draught and part of the boiler plant cut out during some hours. On the other hand, the effect of forced draught on the life of boilers must be considered, and this is a point that it would be well for boiler-makers to investigate. At present there seems to be no definite opinion in regard to the maximum air pressure that can with safety be used with various types of land boilers, and it is extremely desirable to know just where the limit lies, as well as the increase in capacity with various pressures of draught. Until this has been ascertained superintendents of central stations thinking of putting in a blower to assist the boilers over a peak in the load line should carefully consider the subject of the amount of pressure to use.

Telegraphs in Rhodesia.—The report of the British South Africa Company for last year (ending March 31), which has just been issued, gives the total length of telegraphic line under the control of the company south of the Zambesi as 1,354 miles. For the six months ending September 30, 1895, the receipts showed an approximate total of £7,631, and the expenditure £3,389. The construction of the Salisbury-Tete section of the line of the Trans-Continental Telegraph Company, Limited, has been delayed owing to exceptional difficulties, caused principally by the scarcity of native labour, the shortness of water due to prolonged drought, and the rocky nature of the country beyond Mount Darwin. Temporary through connection was made with Tete on October 22, and the communication has been maintained by joining the completed portion of the line from Salisbury to the Portuguese wire, which runs in a southerly direction from Tete by means of a temporary line 62 miles in length. It was originally arranged that there should be no public telegraph office of the company within Portuguese territory, but at the request of the local Portuguese authorities temporary arrangements have been made for the acceptance of telegrams at their local office at Tete. The Portuguese Government have erected a telegraph line from Chinde to Tete, and by using the Trans-Continental line, which runs through the latter place, the shipping community of Chinde is brought into touch with other parts of Central and Southern Africa, as well as with Europe and the rest of the world. The Blantyre section is completed, and the projected extension north of Blantyre has been commenced.

Electro-Harmonic Society.—This evening (Friday) there is to be a ladies' night. The following is the programme:—Part I.: madrigal, "Come, Let Us Join" (Beale), and part song, "Forsaken Am I" (Koschatt), Members of the South London Musical Club; song, "Come To Me" (Wadham), Mr. Henry J. Humm; violin, 'cello, and piano, "Allegro Animato" (from Trio in F) (Gade), the Misses Uhlhorn-Zillhardt; song, "Vainka's Song" (arranged by F. J. Whisham), Miss Emily Humm; 'cello solo, "La Cygne" (St. Saëns) and "Polonaise" (Popper), Miss Ethel Uhlhorn-Zillhardt; song, "The Scent of the Lilies" (Gerard F. Cobb), Miss Ethel Izard; part songs, "Must I Then Part" (Otto) and "Song of the Pedlar" (Lee Williams), Members of the South London Musical Club; humorous song, "The Tin Gee Gee" (Cape), Mr. Harry Jones. Part II: violin, 'cello, and piano, "Allegro Molto Vivace," from Trio in F (Gade), the Misses Uhlhorn-Zillhardt; song, "Queen of the Roses" (Sullivan), Miss Emily Humm; part song, "The Image of the Rose" (Reichart), and chorus, "A Hunting We Will Go" (Harding), Members of the South London Musical Club; piano solo, Mr. Alfred E. Izard; song, "Good-bye" (Tosti), Mr. Henry J. Humm; part song, "The Long Day Closes" (Sullivan) and chorus, "A Chinese March" (Otto), Members of the South London Musical Club; song, "Summer" (Chaminade), Miss Ethel Izard; humorous song, "Sheeny Man" (Rich), Mr. Harry Jones. The musical directors are Messrs. T. E. Gatehouse and A. E. Izard, and the concert takes place at 8 o'clock at the St. James's Hall Restaurant.

Attenuating Toxines.—Messrs. D'Arsonval and A. Charrin, of the Collège de France, have been investigating the action of high-frequency currents on bacterial toxines.

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Former investigators in this direction, and notably Messrs. Smirnoff and Kruger, have confined themselves to continuous currents, in which case the results obtained are vitiated by the chemical action due to electrolysis. Mr. D'Arsonval and Mr. Charrin, on the other hand, have used high-frequency alternating currents, the toxine being contained in U-tubes plunged in iced water in order to prevent heating. As much as 223,000 alternations per second, and a current density of 250 milliamperes per centimetre were used, and the toxines worked with were those of diphtheria and pyæmia. The results were tried on guinea-pigs, and it was found that in every case the effect of the electrical action was greatly to diminish the virulency of the toxines, and that if carried to the proper limit the toxines, thus rendered harmless, sensibly augmented the resistance of the animals to infection of a similar kind, became, in fact, preventive vaccines. If this proves to be the case with the toxines of other bacteria, it will provide a much better method of attenuation than that at present in use, for though in a few cases this can be done by age or drying, it is usually necessary to pass the virus through the system of some unfortunate animal. A purely physical process would not only avoid the appearance of inhumanity, but would give a certain and measurable result instead of one always liable to be affected by unknown factors in the constitution of the animal operated on. Although when the frequency is extremely high the human body can be subjected to the action of an alternating current without any of the effects produced by one of more moderate frequency, it would be probably too much to hope that it might be possible to operate directly in this way on the bacterial products in the body of the patient.

The Official View.—In *El Telegrafista Español*, a journal which may be taken as representing with considerable ability the views of the Spanish telegraphic service, there has appeared a series of articles on the subject of the concession by the State to private companies of the right of erecting either urban telephones or interurban lines. This is considered to be altogether a dangerous proceeding from the point of view of the State, and, moreover, the revenue suffers. One of the conditions imposed upon the Interurban system was that its tariffs should be made uniform with those of the State telegraphs. This, however, our contemporary contends has not been done. Taking, for example, the published tariff of the Interurban system for the stations of Burriana, Castellon, and Villarreal it is remarked that telegrams from Valencia to these stations or from them to Valencia sent over the State lines pay 1·15 pesetas (11d.) for 15 words, while on the telephone system a three minutes' conversation can be had on payment of 75 centimos (7d.), and during those three minutes much more can be said than could be put into three telegrams. As a result, the telegraphic service to Burriana, Villarreal, and Castellon has fallen off so, that as regards the first two there have been days when no message has been sent, and this in spite of it being the time of shipping oranges, during which in other years one operator was not sufficient for the work of these offices. Our contemporary does not wish it to be supposed that it desires to oppose the telephone or to be counted among the enemies of progress in electrical matters, but contends strongly that the telephone service may and ought to be a State service, as it is in several other European countries. As to all this it can only be said that, however annoying it may be to a Government service to find itself undersold by a private company, it will probably be difficult to persuade the Spanish public, who get the advantage, to see the grievance quite so clearly.

Incandescent Lamps.—The *Electrical World* says that those who have followed closely the proceedings of bodies of practical men will doubtless have noticed the tendency toward the widest divergence of opinion in their discussions. Several examples of this were furnished at the recent Milwaukee meeting of the North-Western Electrical Association in the discussion on central-station economy with respect to incandescent lamps. One speaker advised central-station men to use 2½-watt lamps, and even to seek for 2-watt lamps, while another was cautious about recommending an efficiency as low as 3·5 watts. Superficially, the statement that 2½-watt lamps with a life of 300 hours are more economical than 3·1-watt lamps having a life of 600 hours has an appearance of reason, but, as shown by Messrs. Terry and Howell, it ignores several factors of the utmost practical importance in the present state of the incandescent lamp manufacture and of central-station operation. As incandescent lamps are made at present, the higher beyond a certain point the efficiency at which they are burned, the greater the deterioration in candle-power, and the less the ability to stand fluctuations in voltage. If, therefore, the voltage of currents were kept constant, it would not follow as a matter of course that the lamp of higher efficiency would give the best average result; while, under the conditions as to regulation in the majority of plants, the use of lamps of very high efficiency becomes impossible under the present methods of their manufacture. The discussion brought out very strongly the necessity of close regulation of voltage if satisfactory results are to be obtained from lamps of even 3·1 watts efficiency. It would be a great benefit to impress on lamp manufacturers and inventors the absolute need to the incandescent lighting industry, under present conditions as to competition from other sources of light, of a high-efficiency lamp that will have the same qualities as to life and maintenance of candle-power of, say, the present 4-watt lamp. Gas manufacturers in America have been urged by the competition of the electric light to improve their product in view of competition with the 16-c.p. incandescent lamp. Whether with the present class of filament and method of manufacture it is possible to hope for a 50-watt 24-c.p. lamp that will have a life with sustained candle-power of over 300 hours with the fluctuations of voltages encountered with alternating systems and many direct-current plants, seems a matter of some doubt. It is suggested, finally, that by working along new lines an improved lamp may be obtained.

The Telephone Service.—In the House of Commons on Monday last a question was put by Sir John Brunner to the Secretary to the Treasury, as representing the Postmaster-General, as to whether it was the intention of the Department, after the transfer of the telephone trunk lines from the National Telephone Company to the Department, to close these trunk lines at the hours of closing the various post offices, and thus to deprive a large body of subscribers of the convenience hitherto enjoyed by them of making use of the telephone at all hours of the night? To this Mr. Hanbury replied that, from the best information in the hands of the Post Office, it appeared that except in a few cases the telephone trunk wires were scarcely ever used at night, and the Department would not, therefore, be justified in going to the expense of providing attendance after the ordinary official hours. In the first instance, therefore, it was proposed that the hours for telephone business should be the same as for telegraph business, but the Department would give careful attention to the matter and ascertain where the requirements of the public would justify an extension of the hours. At many of the larger offices the telegraph service was open to the public all night,

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and there, of course, the telephone service would also be open. Later on Mr. Tully asked what steps the Post Office proposed to take in reference to the numerous complaints as to the inefficiency and expensiveness of the telephone service supplied by the National Telephone Company, and whether it was the intention of the Government to terminate the monopoly of that company by taking over the entire telephone business, as was done in the case of the telegraphs. Mr. Hanbury replied that if it were proved that the company did not afford a satisfactory service, the Government would consider the advisability of establishing a limited competition. It was not the intention of the Government to take over the entire service before the expiration of the period of the license. It may be added to this that at a meeting of the Telephone Sub-Committee of the Glasgow Corporation it has been decided to ask the Postmaster-General to fulfil his promise of last year to appoint a committee to take further evidence as to the municipalisation of the telephone. As the result of the endeavours of the Liverpool Chamber of Commerce for permission for cablegrams to be transmitted by telephone after 6 p.m. to private addresses, the secretary of the Chamber has received a letter from the Postmaster-General's department intimating that arrangements to this end have been made with the Anglo-American, the Commercial Cable, and the Western Union Companies, and that the National Telephone Company are prepared to co-operate.

Telegrams to France.—Mr. J. Henniker-Heaton, having tried in vain to obtain from three successive English Governments returns of the telegraph and telephone business between England and France, addressed his enquiries to the French Government. The latter have given him what his own Government have refused, the Ministry of Posts and Telegraphs sending him the following letter: "In accordance with the request contained in your letter of the 9th inst., I have the honour to inform you that the number of telegrams exchanged between France and Great Britain amounted in 1894 to 1,216,545, containing together 14,417,260 words, which, at the rate of 20c. a word, represents a total receipt of 2,883,452fr. The number of the messages sent from France was less than the number despatched from Great Britain, France having sent only 548,154 telegrams, with 6,554,041 words, while she received 668,391 telegrams, containing 7,863,219 words. The total receipts were, under the provisions of the convention of June, 25, 1888, equally divided between the two countries, from April 1, 1894, whereas before that date France received $\frac{11}{20}$ths and Great Britain $\frac{9}{20}$ths of the proceeds. As regards the telephonic communications exchanged between Paris and London, they amounted in 1894 to the number of 45,115, which at the rate of 10fr. for each conversation, represents a total receipt of 451,150f. The number of conversations originating in Paris was less than that of the conversations started from London. The former only reached the number of 18,930, while the latter amounted to 26,185. The total receipts were, under the provisions of the convention of November 19, 1891, divided between the two countries in the proportions fixed for the division of the proceeds of the telegraph rates." In a letter to the *Times* Mr. Henniker-Heaton remarks: "Satisfactory as these returns are, there is a matter of grave complaint in connection with them—I mean the heavy charge for transmission of telegrams. The inland rate in Great Britain is ½d. per word; in France it is slightly less than ½d. (5 centimes). The rate between the two countries should be the sum of the two inland rates—that is, 1d. per word. Commercial readers need not be told of the immense stimulus to Anglo-French trade which this common-sense cumulative rate would administer. We can telegraph from London, by a submarine cable 100 miles long, to Jersey for ½d. a word, but to telegraph to Calais, by a cable 30 miles long, costs 2d. per word. So while a letter to Calais costs 150 per cent. more, a telegram to Calais costs 300 per cent. more than a similar letter or cablegram to an island nearly three times further away. From enquiries, I am disposed to think that if the British Ministry proposed a penny tariff the idea would be heartily welcomed in France."

Electric Lifebuoy.—The American papers contain descriptions of an electric lifebuoy which has been tested on board the lighthouse tender "Armeria," and favourably reported upon to the United States Lighthouse Board. The buoy consists of a ring mounted in a framework of metal tubing. The ring is normally in the plane of the frame. When the buoy is dropped into the water the ring on which the buoy floats turns so as to rest with its side on the water, and on so turning operates an automatic switch controlling the lights in the manner described below. At the lower end of the frame is the battery-box, containing the cells. To keep this perfectly dry inside, a moisture absorber is placed there with the cells. The box cover is easily removable and made watertight by a packing of rubber with wax or tar. The framework passes from the ends of the battery-box upward, meeting to form an arch above the ring. On top of this arch is the lantern, a glass globe covering one or more pairs of incandescent lamps. Electrical connection between these lamps and battery cells is through the tubes of the framework on both sides. On each side of the frame is a switch-box, containing the automatic switch controlling the circuit. The ring is mounted upon trunnions journaled in the switch-boxes. Where the trunnion enters the switch-box it is surrounded by a watertight stuffing-box to better protect the switch. The stationary contacts of the switch are secured to the frame and box, and the movable contacts are secured to the ring trunnions, but, of course, both sets of contacts are insulated from their supports. These contacts are so related to each other that the turning of the ring but a very small angle out of the plane of the frame will close the circuit and light the lamps, which will remain in circuit until the ring can be turned around nearly one complete revolution. This precaution is very important, because it ensures the continuous glow of the lamps in a rough sea. There is also a hand switch to the lamps and a bell. In reference to this the New York *Electrical Engineer* says: "A very interesting problem here is that of battery power. The lamps will be from three to eight volt, from ½ c.p. to 8 c.p., or more, and in every case will take about one ampere of current. The market can now furnish cells of which six in multiple series of three can glow continuously a couple of 1-c.p. lamps one hour. Connected in the same way, 18 such cells can glow these lamps three hours, and 36 of them can glow the same lamp six hours. More hours can be gotten by adding cells." After referring to the subject of recharging the accumulators, our contemporary adds: "There is now being designed a salt-water battery of such power that it will glow a strong light for several whole nights continuously when overboard, its capacity being large, without occupying much room.' The ordinary calcium phosphide "flare up" may not last quite as long as is desirable, but surely something less expensive and elaborate, not to say rough and ready, than the new buoy would be more likely to come into common use.

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INTERCOMMUNICATION IN RAILWAY TRAINS.

BY J. PIGG.

"Every company shall provide and maintain in good working order in every train worked by it, which carries passengers and travels more than 20 miles without stopping, such efficient means of communication between the passengers and the servants of the company in charge of the train, as the Board of Trade may approve."

"To call the attention of the guard and driver, passengers must pull down the cord which will be found outside the carriage close to the cornice over the window of the carriage door. There are cords on both sides of the train, but that on the right-hand side in the direction in which the train is travelling is the one by which alone the communication can be made."

The first of these extracts is from Sec. 22 of the Act of Parliament 31 and 32 Vict., cap. 119, and, as will be seen, makes it obligatory for railway companies to provide such means of communication as, in the opinion of the Board of Trade, is efficient. The remainder of the section enumerates the penalties incurred by railway companies for neglecting to provide such communication and by passengers for unnecessary use thereof.

The second extract is a copy of the printed instructions to passengers for their guidance in using the communication between passengers and officials in charge of the train, and may be seen in almost any railway carriage in England.

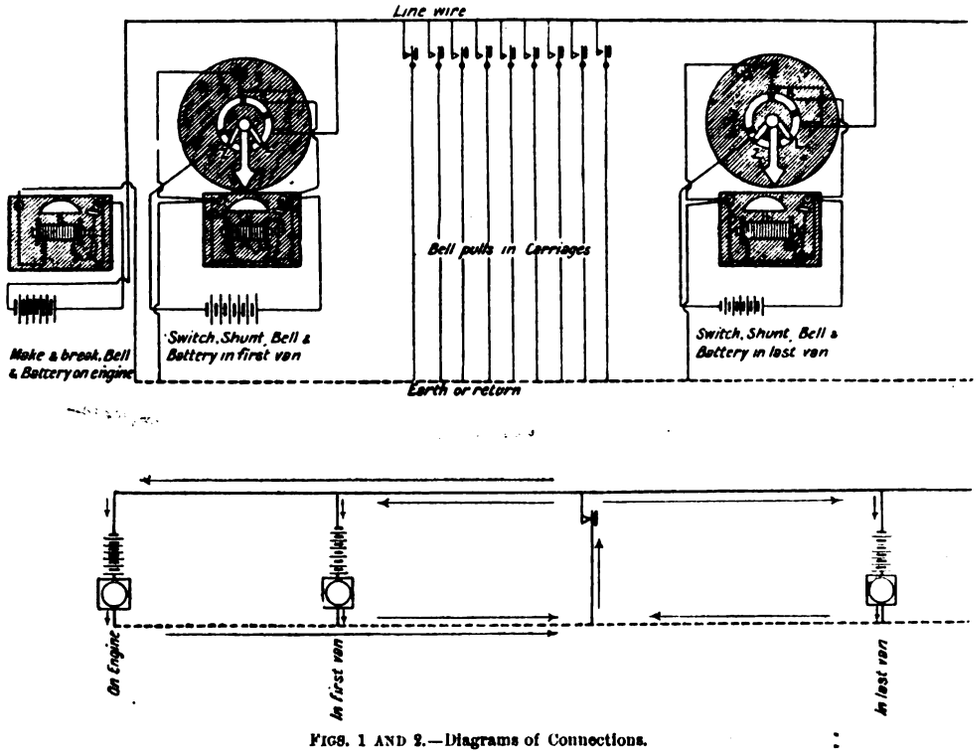
Of the necessity for some means of communication there can be no possible doubt; the "separate cell" construction of English passenger rolling-stock makes it imperative.

No doubt the corridor train is the train of the future, and it has already obtained a slight footing in this country for certain classes of trains, but the change must, of necessity, be very slow on account of the large amount of capital invested in the existing class of carriages, and must, therefore, even if taken in hand at once, extend over many years before the conversion can be completed. Hence, it would appear that the necessity for means of communication will not immediately disappear, and it becomes of interest to consider what has been done towards complying with the requirements of the Act quoted and also in how far they may be regarded as satisfactory.

The most general mode of communication is by means of a cord stretched along the whole of the train, outside, and immediately over the carriage windows. One end terminates on the engine, where it is connected to the engine whistle; the other end terminates in the guard's van, where it actuates a bell. Instructions similar to those already quoted are posted in every compartment of the train.

The arrangement, which is wholly mechanical, is simple to work, cheap in construction, and does not require any special skill in its manipulation. The varying requirements of the train at different stages of its journey are easily met, the stock of apparatus to be kept on hand for repairs, etc., is simple in character, and the device, when used, is certainly effective. Its one vital defect is its comparative inaccessibility under certain circumstances which call for its use, but which need not be more particularly specified here. To put down the carriage window on one particular side and pull the communication cord would, in some cases, be quite impossible, however urgent the need, and, therefore, simply on account of this lack of easy use, the cord communication must be considered as comparatively ineffective, notwithstanding its numerous other advantages.

Considerable attention has been given to the provision of electrical communication as a substitute for the mechanical arrangement, and a few years ago a valuable prize was offered by the chairman of a southern railway company for a method of adapting the telephone to this class of work.


Line wire
Bell pulls in Carriages
Make & break, Bell & Battery on engine
Switch, Shunt, Bell & Battery in first van
Switch, Shunt, Bell & Battery in last van
Earth or return
On Engine
In first van
In last van

FIGS. 1 AND 2.—Diagrams of Connections.

The offer, so far as the writer is aware, was not taken up. The noise and vibration on a railway train in rapid motion are effectual obstacles to the use of such a delicate instrument as the telephone. Moreover, the possibility of conversation being carried on between any of the officials in charge of the train and a passenger is, in itself, in conceivable cases, evidence that the need is not urgent in the extreme. Passengers have constantly before them the fact that the use of the means of communication will be interpreted by the officials as indicating the necessity for bringing the train to a stand as quickly as possible. There is thus no need for an elaborate code of signals, or for means of carrying on a conversation; an arbitrary signal of the character of which there can be no doubt, is all that is required.

Railway companies have made some efforts in this direction, and as an illustration of the means adopted to meet the requirements of the service by substituting electrical for mechanical signalling appliances, the electrical part of the method in use on the South-Eastern Railway is shown in the diagrams.

In devising the method of working, considerable ingenuity has been exercised in making arrangements for testing the circuits at any time, for continuance of the alarm as long as may be necessary, and for locating the point from which the alarm has been given.

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The arrangement shown in Fig. 1 is the normal condition for use by the passengers to give an alarm. On the engine a "make-and-break" bell and a six-cell battery are fixed, and in each van a switch, "shunt" bell, and six-cell battery are placed. In each separate compartment of the train a bell-pull is fixed, by which passengers are able to complete the circuit. The three batteries are opposed to each, as in Fig. 2, which is the arrangement of Fig. 1 simplified, and shows by the arrows the direction of the currents when a contact is made at any point between the two vans. Obviously, a "short-circuit" made anywhere on the train will cause all the bells to ring, and they will continue to do so until the circuit is broken again. By turning the switch handle to the right either guard is able to give an alarm if he sees the necessity, and is able to leave the bells ringing whilst he attends to such duties as the reason for the alarm renders necessary. By turning the handle upwards, the apparatus in that van is cut out of circuit and made inoperative.

It will be noticed that a defect in the apparatus does not, of itself, give any indication to that effect, and, consequently, the apparatus must be frequently tested in order that its condition may be known. The testing is done by the small push button shown above the switch.

The necessity for preventing mischievous use of the communication, and for locating the position from which an alarm has emanated, has been met by the mechanical connection of a small semaphore arm with the bell-pull, which, when the latter is used, projects from the carriage side. The bell-pulls are also arranged so that they can only be replaced by the guard after having been used. In this way it is comparatively simple to locate the point from which an alarm is given.

In some cases there is a separate semaphore arm and bell-pull to each compartment. In other cases a rod runs along the whole length of the carriage, and carries only one semaphore arm at one end. The pulls in this case are connected mechanically to the rod, and the use of any pull causes the rod to rotate and show the semaphore arm, and at the same time makes an electrical contact, which gives the alarm to the officials. The projecting semaphore arm indicates the carriage, and the position of the pull indicates the compartment of that carriage from which the alarm was given.

The system is fairly complete, and, since it has been in use some years, it may be assumed to meet the requirements of the company using it, but it would appear as if the first cost and maintenance would be much greater than for the usual cord communication.

If we contrast the electrical method just described with the cord communication, we find that if the former is more accessible owing to the number of points from which signals may be given and the greater facilities for reaching them, the latter holds an enormous advantage in the greater ease with which changes, rendered necessary by alterations in the composition of the train at different stages, can be made. The rock on which projects for electrical train communication have hitherto been wrecked is, as in train lighting, this breaking up of trains into sections at different stages of the journey, and the attaching of vehicles which may not be adapted for the particular method of communication employed on that train.

The rolling-stock of any one company is not confined to that company's lines alone, but is very frequently found on the lines of neighbouring companies. If all railways who interchange rolling-stock adopted one and the same method of electrical communication, nothing could well be said against such methods as are in use or have been suggested, provided all the rolling-stock were fitted up simultaneously. This last condition is, of course, not to be expected, and since existing or suggested methods of electrical communication do not seem adapted to work in conjunction with the existing mechanical arrangements, the former would appear, at first sight, incapable of fulfilling all the conditions of the railway service. From these considerations we are led to infer that any electrical system of train communication which will receive more than passing attention from railway officials must, of necessity, be capable of being used in conjunction with the system it is intended to displace, until the older and less efficient method is completely replaced. In the writer's opinion, it is to the persistent neglect of these requirements that the comparative failure of electricity for train communication is to be attributed.

Not the least requisite for a complete system of electrical communication is the organisation of the means of keeping the apparatus in a state of constant efficiency, more especially on lines which constitute part of the through routes of the country. An efficient system of testing the apparatus is, no doubt, very desirable, but, since the object of all testing is the detection of faults before they become apparent in the actual work for which the apparatus has been fixed, unless the testing is supplemented by an equally efficient means of remedying defects it becomes proportionally valueless. If all trains were run *en bloc*, or if trains always consisted of the same vehicles, and were subject to the same changes *en route*, the organisation of the maintenance would be comparatively simple, seeing that railway companies have linemen stationed at all important stations, and at many of less importance, whose duty it is to look after the maintenance of the company's electrical apparatus within a certain district. Unfortunately, as everyone acquainted with railway working is aware, these conditions are not attainable. The train service of a railway is constantly varying, and there is no certainty that any vehicle will always be available for certain work, or that any given number will always be available for the composition of a particular train. For these and similar reasons, it would appear that the organisation required for the maintenance of electrical communication in a constant state of efficiency will require to be very complete, and the details must be arranged with more than ordinary care.

It may be thought, from the tone of the previous remarks, that a somewhat pessimistic view of the prospects of electrical train communication has been taken. This is not the case, but it would appear from the considerations of the requirements to be met that any system, to secure general adoption, must proceed on radically different lines to those hitherto followed, and that the first thing to be done with the object of securing an acceptable system for general use is to fully understand and face the requirements of the service.

MUNICIPAL WORK AT COLOGNE.

RESULTS OF COMBINED WORKING OF WATER AND ELECTRIC LIGHT WORKS, BY MESSRS. C. P. FELDMANN AND ENGELBERT FROITZHEIM.

The details of the electricity works at Cologne were fully given in our recent issues (pages 89 and 120). As then explained, the municipal waterworks occupy an adjacent site, and by combining the electric station and the waterworks, considerable advantage has been obtained. In the first place, it was not necessary to acquire a special site for the electric station. The plans for gaining water would have necessitated a much larger area of ground than that required only by the buildings for the pumping plant. The wells are now arranged at distances of 50 metres (54·5 yards from one another, and this is the least distance allowable if the normal output of each well is to be maintained. If the distance between two adjacent wells is smaller, the areas from which they obtain water overlap so much that the total output is diminished, and, starting pumping from one well, the water-level in an adjacent well, not working, is lowered to a certain measurable degree. With 50 metres (54·5 yards) distance this mutual disturbance is but small; still, the total area of extraction of water by one well covers a radius of 200 metres (218 yards) diameter. Besides, if the surface water obtained satisfies the strictest sanitary requirements, it is necessary to have a considerable area free from all structures, as the drainage from the buildings might infect the water. The danger of infection may be considered as excluded as soon as the area of supply, which in this case embraces a radius of 200 metres (218 yards) diameter, is kept free from all houses, etc. For these reasons the waterworks required an area like the present one, even if the electric

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station had not been combined with them. In spite of this fact, and in order to avoid any error as to the real earning power of the electric station, the latter indemnifies the waterworks by paying them a tax of 3,000 marks (£150, about) annually, which corresponds to the interest on about 100,000 marks (£5,000 about). For this sum, however, it would not have been possible to obtain an equal area in any part of the city.

In the second place, the combination has diminished the initial cost of both works. As mentioned in the preceding articles, the waterworks required a second boiler-house similar to the old one; this can be dispensed with by working both sets of engines from the large new boiler plants. The maximum output of the two works never coincides. The largest consumption of water takes place during the day and the summer months; the maximum output of the electric station is attained in the evening and during the winter months. The boiler plant is therefore worked at a nearly constant rate of steam production throughout the year—that is, the load is practically constant.

In the third place, therefore, the total costs of steam production are greatly reduced. These costs are made up of the outlay for fuel and for wages. The electric station works with a load corresponding to the whole number of lamps connected to its mains during 1·3 hours a day. As it is an alternating-current station, and runs continuously, its boilers have to be kept working without intermission with a widely varying rate of steam production. During the large number of hours of small load the loss would be nearly constant and rather high. Similar conditions would be obtained if the waterworks were working alone. How much these losses would have cost cannot be stated with regard to the electric station, as this has never worked alone, but they are clearly pointed out by the coal bill of the waterworks. Before erection of the electric station 526 kilogrammes (1,157lb.) of coal were used for 1,000 cubic metres (35,200 cubic feet) of water supplied; after erection of the station only 478 kilogrammes (1,052lb.) were consumed. As the output for the last year (and for the new works, of course) was 6,315,000 cubic metres (223,000,000 cubic feet), the total saving of coal makes 3,000 marks (£150, about). The total amount of fuel is distributed between the two works according to their daily number of horse-power hours. This distribution is made every day. It is not necessary to explain that the total wages of the firemen are less for both works than they would have been for each of them separately.

In the fourth place, the immediate neighbourhood of both works provides cheap and good water for condensing for the electric station. Had the latter been within the city, it would have been necessary either to erect and to work a special pumping plant or to take water from the supply pipes. In both cases the outlay would have been much higher than at present. It was very favourable that in the present case the whole work of raising water was divided, thus allowing the water to be taken (without reaching the total pressure) from the first reservoir. The water may, therefore, be sold at a low price, equal to the waterworks own costs for the work spent on it. The waterworks revenue from water used for condensing purposes is about 3,000 marks (£150, about) annually. The total earnings of the waterworks from the central station are therefore 6,000 marks (£300, about), or about 20 per cent. of the total outlay for coal, which amounts to 30,000 marks (£1,500, about) annually.

In the fifth and last place, the costs of administration are diminished by the combination. The work is superintended by an engineer, assisted by a second man, who does the writing. The latter keeps the wages books and stores, etc., and the lists of the daily output and consumption. The service is controlled by two foremen and a manager, the former watching over the day and the night shifts respectively. A doorkeeper notes persons and goods that enter and leave the ground; in addition, he works the weighing-machine and controls the total amount of coal introduced. The coal consumed is weighed in the usual way by the firemen. These latter, as well as the rest of the workmen, have to begin with the simplest work. Only strong young fellows are taken, who have to begin as helpers with handing in coal, putting out ashes, etc.; in due time they advance, and become helpers for the firemen, and afterwards firemen. In the same same way the engine drivers are educated, but they must have finished their apprenticeship in a smith or engineer's shop before entering the works service. These engine drivers have to work both sets of engines, so that sickness or strike are not likely to disturb the regular service to any great degree. The whole rooms for the administrative work, the doorkeeper, and the workmen are common to both works, thus forming another point of saving in first cost.

In this way the combination has proved successful for both works, and especially the electric central station has obtained financial results which make it one of the best working stations of Germany in spite of the short time of its existence.

THE "JANDUS" LAMP.

REPORT BY PROFS. HOUSTON AND KENNELLY.

We beg to submit the following results of our measurements of the candle-power and rate of burning of carbons of the lamp placed in our hands for examination. The lamp submitted to us is designed to operate on incandescent circuits of from 90 to 120 volts pressure. In order to determine the rate of consumption of the carbons, we operated the lamp daily from July 19 to August 1 last, making in all two runs of 50 hours each. We found the average rate of burning of the positive carbon to be 0·057in. per working hour, and of the negative carbon 0·015in. per working hour.

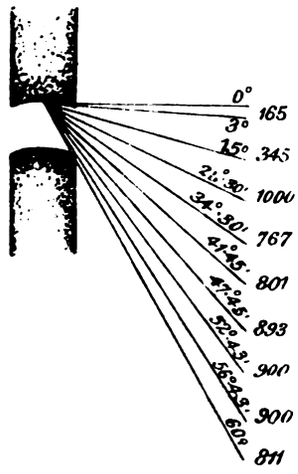

FIG. 1.—Jandus Incandescent Arc Lamp Test made by Prof. Edward Houston and Dr. A. E Kennelly through two clear glass globes.

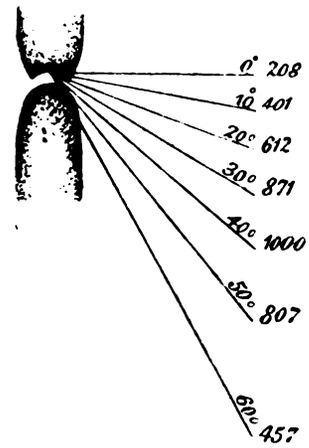

FIG. 2.—Average of 26 Ordinary Arc Lamps. Official test made by Wybauw with naked arc.

According to this rate, the positive carbon, which is 12in. long, of the solid "Electra" type, and ½in. in diameter, would last 210·5 hours; and the negative carbon, which is 6in. long, and also of the solid "Electra" type, would last 400 hours, assuming that the carbons could be entirely consumed. The lamp, therefore, requires to be recarboned only at comparatively long intervals. The average current supplied to the lamp from 400 observations was 5·60 amperes. The power consumed by the lamp at 110 volts pressure represents 616 watts, or 0·826 e.h.p. The pressure between the carbons of the lamp when in operation averaged about 80 volts, and the resistance permanently inserted in the lamp effected a drop of pressure of approximately 30 volts, thus enabling the lamp to be used on a 110-volt circuit. The apparatus may be regulated so as to carry the current strength and power absorbed, and we have observed one of your lamps taking an average current of 4·5 amperes. Owing to the comparatively large pressure between the carbons, one of these arc lamps can be inserted in a single-branch circuit across 115-volt mains, and, on the other hand, the arc obtained is a long one, and thus the shadowing of the positive crater by the negative carbon is largely avoided.

The lamp is simple in its mechanism and efficient in operation. It only employs a single magnet, which

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regulates the position of the upper or positive carbon. We found the arc to be very quiet, and rarely to flicker. It is suitable for indoor as well as outdoor illumination. The carbons being completely enclosed, no sparks or hot carbon dust can fall from the lamp and set fire to inflammable material which might be placed beneath it. The lamp is provided with two glass globes, an outer and an inner. The long life of the carbons is due to the fact that the presence of these globes maintains around the carbons an atmosphere free from uncombined oxygen. In measuring the candle-power of this lamp, both of these globes were of clean and clear glass. The lamp was raised and lowered by a rope near the photometer, so as to measure the candle-power at different angles of elevation and depression. Our standard of luminous intensity was a Hefner-Altneck amyl-acetate lamp, and our secondary standard an incandescent lamp burning at an efficiency of about $\frac{1}{2\cdot5}$ candle per watt. The maximum candle-power observed in any position was 1,295 standard British candles. The following are the mean results of two sets of observations at various angles:

Angle of elevation.		Luminous intensity. (British standard candle.)
	− 25° 30′	141
	− 19° 30′	145
	− 8° 15′	177
Depression	3° 30′	189
	15°	396
	25° 30′	1,148
	34° 30′	869
	41° 45′	920
	47° 45′	1,025
	52° 43′	1,032
	56° 43′	1,035
	60°	931

Under the conditions above described the maximum candle-power may be taken at 1,300 British standard candles. During the tests for candle-power the lamp was operated under practically the same conditions of pressure and current as during the test for consumption of carbons.

SWINBURNE'S NEW VOLTMETERS, AMMETERS, AND WATTMETER.

BY W. PERREN MAYCOCK, M.I.E.E.

Swinburne's Electrostatic Voltmeter (Holt's Patent).—A plan of this instrument with dial removed is given in Fig. 1, and a side-sectional view in Fig. 2. Fig. 3 gives a separate sketch of the vanes and pointer. Q_1, Q_2, Q_3, and Q_4 (Fig. 1) are four quadrant-shaped brass cases, the form of which will be more clearly seen from Fig. 2, where a section of Q_1 and Q_3 is given. Q_1 and Q_3 are connected together, as are also Q_2 and Q_4, the position of the connecting brass strips being shown dotted at *w* and *w'* (Fig. 1). Q_1 is connected with one of the terminals and Q_2 with the other, the connection being through fine copper fuse wires enclosed in glass tubes. In the event of any sparking or arcing taking place between the differently charged parts of the instrument, the resulting current fuses these wires, and any short-circuiting of the mains to which it may be connected, as well as damage to the instrument, is prevented. These fuses are on the outside of the case at the back, and are thus easily got at for renewal. One of them is shown at F (Fig. 2), their position being shown dotted at F and F′ in Fig. 1. The parts of the instrument are mounted on a thick ebonite base (shown black in Fig. 2), and the surface between the quadrants is corrugated, as at C, C, C, C (Fig. 1), to increase the insulation and prevent leakage between the oppositely-charged quadrants. For this purpose also the terminals are very highly insulated, one being shown at T (Fig. 2): the terminal shank is enclosed in an ebonite tube, E T, and its inner end provided with an ebonite cap, E C. The position of the terminals and their ebonite caps is shown at T and T′, E C and E C′, in Fig. 1. The pointer, P, and vanes (of which there are two), V V′ (Fig. 2), are mounted on a light steel spindle resting on friction wheels, F W (Figs. 1 and 2). This kind of bearing, which enables the spindle to turn very easily and freely, is as follows: two small wheels with smooth sharp edges are mounted side by side in jewelled or highly-finished bearings, so that they overlap, but do not touch; the end of the spindle rests between and on their top edges. The front vane, pointer, and counterweight are shown in Fig. 3. The vanes and pointer are of aluminium, and to decrease their momentum and render the instrument more dead-beat, the former are perforated: their peculiar shape will also be noticed. P projects round in front of the scale, S, as shown in Fig. 2; the position of S is shown dotted in Fig. 1. It is obviously important that the instrument be set up perfectly level, and for that purpose a spirit-level, S L (Fig. 2), is provided. The instrument is adapted to the measurement of either direct or alternating pressures, and is made in various ranges—800 to 1,600; 1,400 to 2,600; and 1,800 to 3,200 volts being the ordinary. It can, however, be made to read up to 8,000 volts, and in a different form to 50,000 volts. Its action is as follows: As seen in Fig. 2 the vanes are in connection through the spindle and bearings with the quadrant Q_1, and thus Q_1, Q_3, and the

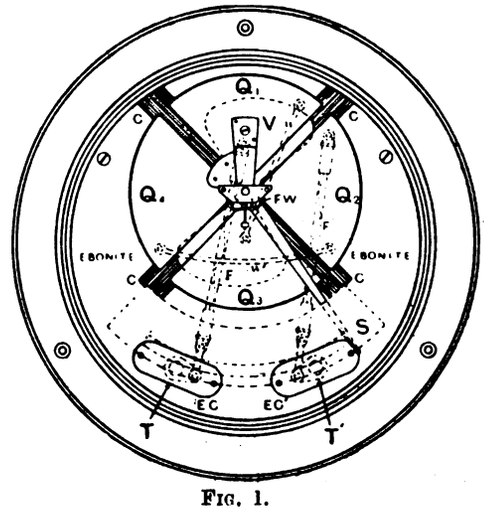

FIG. 1.

vanes are in connection with one terminal, T, of the circuit, Q_2 and Q_4 being joined to the other, T′. The zero position of the vanes is shown dotted in Fig. 1; it will there be seen that they project slightly from the enclosing quadrants. Suppose the terminals, T and T′ (Fig. 1), are connected respectively with the + and − points in a circuit, the pressure between which it is desired to measure: Q_1, Q_3, and the vanes will become + ly electrified, and Q_2 and Q_4 − ly electrified; the vanes will consequently be repelled by Q_1 and Q_3 and attracted by Q_2 and Q_4, against the force of gravity acting on the counterweight: the projection of the vanes when in the zero position will cause them to move round in a clock-wise direction, and the pointer will move from right to left. The same reasoning applies with

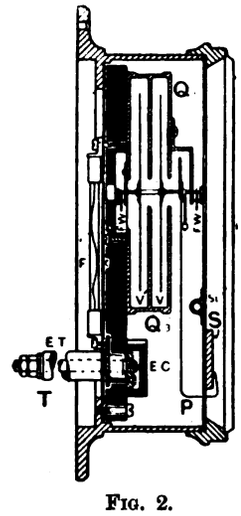

FIG. 2.

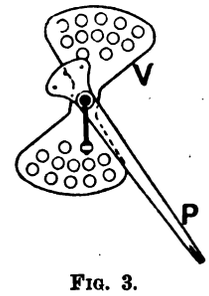

FIG. 3.

an alternating pressure, it being remembered that, though the electrification is rapidly alternating, the vanes, Q_1 and Q_3, are always similar in electrification, and opposite to Q_2 and Q_4.

Swinburne's "N" Type Voltmeters and Ammeters.—These instruments consist of a pair of astatic needles and a current-carrying coil: the principle of action is thus the same as that of an ordinary astatic detector. They are clearly only adapted for direct-current work, but by reason of their construction are claimed to be unaffected by neighbouring fields, and to be cheap. The interior of a voltmeter is shown in Fig. 4, the exterior being very similar to that of other instruments. B F is a brass skeleton frame, on which is wound a coil of fine wire, C, of about 800ω resistance; another coil, R, of platinoid wire and about 3,200ω resistance is joined in series with C, and the two are connected with the terminals, T and T′. The use of R is to reduce the current passing through the instrument, and to minimise any error due to the current heating the coil and increasing its resistance. The turns of the coil are opened out

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at O to enable the needles to be put in place. The latter, one of which (N) can be seen in the figure, are of thin sheet steel carefully magnetised, and the poles being close together are little affected by external fields. The flatness of the needles and the closeness together of the poles (giving a nearly closed magnetic circuit) is the special feature of this instrument. The needles and pointer, P, as well as two counterweights, C W, C W′, are fixed to a steel spindle mounted in bearings, one of which (B) can be seen on the front of the coil. C W is used

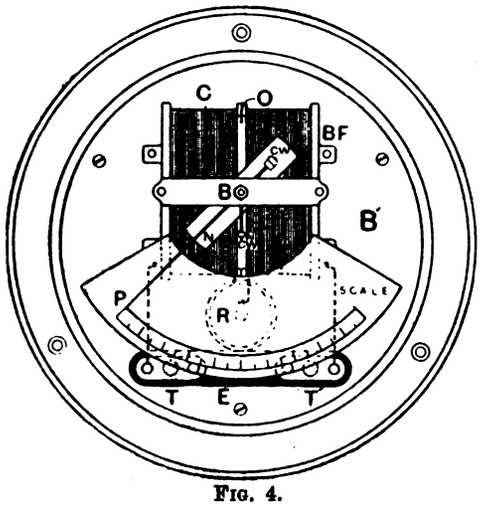

FIG. 4.

to balance the needles and pointer, while altering C W′ increases or diminishes the sensitiveness of the apparatus. The parts are mounted on a sheet-iron base, B′, and the terminals on an ebonite block, E, shown black. Voltmeters of this type are generally constructed for ranges up to 100 or so volts, but can, of course, be made to read to higher values. Fig. 5 shows an ammeter coil for this type of instrument. The winding consists of a single turn of copper strip carefully insulated from the brass frame. It is in two pieces, P and P′, joined in parallel; one joint is shown at J, the other being below. T and T′ are the terminals. For heavy currents the instrument is arranged as a shunt across a low resistance in the main circuit, so that the heavy main leads need not be led to and from the instrument.

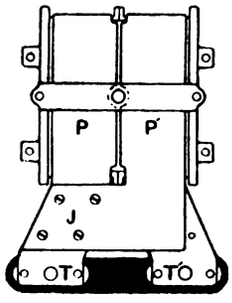

FIG. 5.

Swinburne's "Inductor" or "U" Type Instruments.—This type of instrument for alternating-current work, which may be fitted either as a voltmeter, ammeter, or wattmeter, is unique in principle, and though not complicated in construction, its action is somewhat difficult to explain clearly. I C (Figs. 6 and 7) is a square-shaped iron core built up of thin sheets of soft iron in two pieces, which are bolted together at the joints, J and J′, the larger sheets having a projecting piece, P. These sheets or stampings are insulated from each other with thin paper to prevent the setting up of eddy currents. A closed magnetic circuit is thus provided for the two coils, C_1 and C_2, which are of copper wire and joined in series, while the magnetic flux due to the third coil, C_3, completes its circuit across the air gap, G. C_4 is a coil of a single turn, three sides of which are made of copper strip, while the fourth side, which moves in the field gap, G, is of manganin, to retard the setting up of induced currents in it. C_4 embraces the iron core, I C, and is fixed to an arbor or spindle, together with a pointer, P, and counterweight, C W. The fixing of the parts to the ebonite base, E B, is clearly shown in Fig. 7. The terminals, T and T′, are like those of the electrostatic voltmeter above described, but they are unprovided with ebonite caps when the instrument is only used for low pressures, as in the accompanying figures. The action of the instrument is briefly as follows: The passage of an alternating current through C_1 and C_2 sets up a magnetic flux in the core which induces an alternating current in C_4. C_4 being movable, and one side of it being in a correspondingly alternating field due to C_3, that side will travel along the air gap, G, and C_4 and P will be rotated. C_1 is the same whether the instrument be used as a voltmeter, ammeter, or wattmeter; but the connection and winding of C_1, C_2, and C_3 differs in these various cases. In a voltmeter C_1 and C_2 are of copper wire (about ·02in. diameter), connected in series to the terminals, and of a low resistance. C_3 is of fine German-silver or manganin wire wound to a high resistance, and joined as a shunt to the termi-

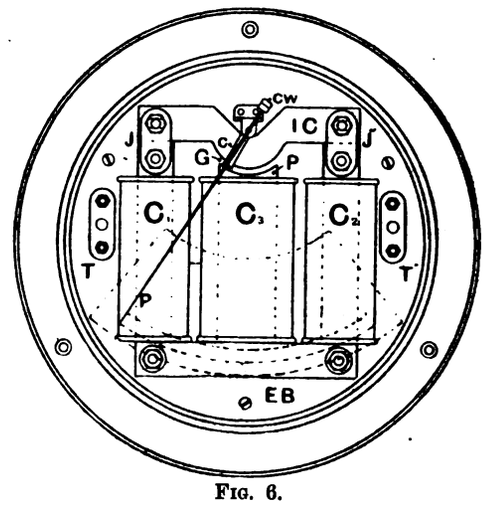

FIG. 6.

nals, T and T′. In an ammeter the connections are just the same, but C_1, C_2, and C_3 are wound with much thicker wire. In a wattmeter C_3 has a copper winding of low resistance, and is joined up in the main circuit; while C_1 and C_2 are wound the same as in a voltmeter and connected in series with two separate

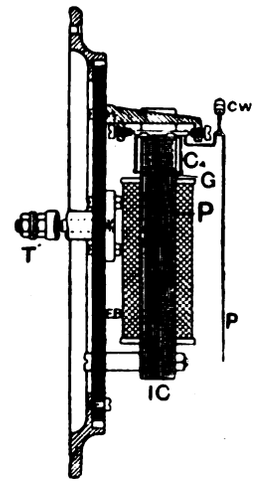

FIG. 7.

terminals. As before mentioned, the main current is sent through C_3, while C_1 and C_2 are connected as a shunt to that portion of the circuit whose power is to be measured.

ELECTRIC WELDING.*

BY T. SCOTT-ANDERSON.

It will perhaps be desirable to devote attention to two processes—(1) the one named in this country the Benardos system, and (2) that of Dr. Zerener, which is called the deflected arc method of welding. In doing so no injustice will be done to the earlier Thomson system if the writer refers the members to a paper on the "Thomson Electric Welding Process," read by Mr. Dobson at the Manchester meeting of the Society of Mechanical Engineers. A fourth, the Hoho-Lagrange system, may be mentioned, but as far as the writer's knowledge goes no plant on this method is yet working in England. The last-named process relies for its heating properties upon the following conditions: a wooden tank (lead-lined) is filled with acidulated water to a density proportionate to the voltage or electrical pressure used, one pole of a dynamo is connected directly to this inner leaden sheath, and the remaining pole is coupled to the bar of steel or other article

* Abstract of paper read before the Federated Institution of Mining Engineers, February 19, 1896.

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to be heated; this system therefore needs the use of a tank or bath large enough to receive the metal which requires heating. The moment the bar touches the water electrolysis of the acidulated water is set up, the water is split up into its component parts, oxygen going to the leaden sheath, and hydrogen rushes to the bar of steel or other article being heated; these particles or globules of hydrogen cling to the metal, and form a complete gaseous envelope around it, so that the metal is actually no longer touching the water. The hydrogen sheath offers a large resistance to the flow of current, and the whole energy is thus transformed into heat. For case-hardening of small articles, for hardening and tempering of steel wire, knife-blades, and similar articles, the process may find useful employment; but where large masses of metal have to be treated the large expenditure of current would, in the writer's opinion, be prohibitive. One considerable advantage is, however, evident—viz., that the heating being effected under water no oxidation of the metal can take place. A continuous current at a pressure of about 200 volts is used for this process. The temperature, however, is not easily controllable, and the utility of the process appears to be confined to easily weldable iron or low-grade steel and to pieces of simple form.

The Benardos or Arc System.

In the Benardos or arc system the article to be operated upon is made to constitute one pole of the electric circuit, while a carbon pencil attached to a portable insulated holder, and held by the workman, constitutes the other pole, the electric arc (which is the heating agent of the process) being struck between the two poles thus formed. When steel or iron is being welded it is usual to make the carbon the negative pole, and the steel or iron the positive pole, but for other metals the poles are sometimes reversed. In welding lead, for instance, it is usual to make the carbon the positive pole. This process has during the last two or three years been considerably improved in detail at the works of Messrs. Lloyd and Lloyd, Birmingham, and elsewhere. In Sheffield there are eight plants doing most satisfactory work in various ways.

The method of working is simple, and is practically the same in all cases at Messrs. Lloyd and Lloyd's. Several low-tension continuous-current dynamos are used. During periods of light loads these dynamos are employed in charging a number of sets of Benardos accumulators or secondary batteries. At times of normal loads, the dynamos supply current direct to the welding shops. When extra current is required, provision is made whereby a large discharge from dynamos and batteries combined is obtained. In parallel, with the dynamo and batteries as many welders or welding machines can be connected as may be desired, and every workman is able independently to vary his current and pressure to suit the work in hand at the moment. One terminal of each welding system is connected by means of a flexible cable to a carbon pencil held in an insulated holder, which is in turn held by the workman, while the other terminal of the system is connected to the table on which the work lies, or to the work itself. The special advantage of this arrangement of resistances and accumulators is that it admits of wide limits of variation of current and pressure to suit the different classes of work which may be in progress.

In passing from this part of the subject, we come to a more important one—viz., what has been done by the Benardos system—and an explanation of the simplest and cheapest method of doing similar work. A slot-link of the reversing engine broke, and stopped the mill. The broken pieces were placed together and electrically welded at the points of fracture, after which the link was fitted and erected, and the engine with the repaired slot-link was running again within one hour from the time of original breakdown. This slot-link continued to work for ovsr 12 months without trouble, and until the engines were eventually removed. A shaft with flange coupling keyed on one end. The continual reversing of the engine to which this shaft belonged, together with the heavy nature of the work done, started the keys, which in turn damaged the edges of their key-beds, and also the bed of shaft coupling. The damaged parts were welded up again, and the bed of the shaft coupling turned, new keyways cut, and coupling keyed on as before. This example is only one of several shafts which have been treated in the same way—many of them being done *in situ*, and always with excellent results. Apart from the general work done by the Benardos process in the repair of slightly defective steel castings, many other instances might be cited where repairs of a similar nature to those already described have been done, such as welding in the teeth of cast-iron wheels which have been broken while working, without removing the wheels from their shafts, but one more example must suffice before proceeding to treat of the application of the process to boiler repairs.

Cutting and Boring.—Another very simple application of the electric arc is that of cutting and boring metals roughly to shape. In work of this kind the same methods of procedure apply as in all the other cases cited—viz., that the article to be cut is made to form one pole, and the carbon pencil the other pole. Under these conditions, if the carbon pencil be brought into contact with the metal to be operated upon, an arc is immediately struck between the carbon pencil and that part of the metal in contact with it at the time, with the result that the metal is instantly melted in the immediate vicinity of the arc, and may be allowed to flow away as it is melted. In this way holes may be pierced in steel, iron, or other plates with great rapidity, and by gradually moving the arc the holes may be elongated into slits of any required length or shape at the option of the workman.

Plant and Apparatus Required.—The plant and apparatus necessary to effect all ordinary repairs, or to perform the operations of cutting and boring, may be of the simplest description, and where an ordinary low-tension electric installation is in operation practically everything necessary is in stock. The dynamo should be of compound-wound type, having a capacity of 250 to 350 amperes at a pressure of 70 to 90, preferably about 85, volts. The cable from the positive terminal of the dynamo should be carried direct to the welding table or to the article to be worked. The negative cable should be carried from the dynamo to the regulating resistance, and thence to the carbon-holder, which the workman holds. The face and eyes of the workman must in all cases be protected, that portion of the protector covering the eyes being of coloured glass, preferably in three separate thicknesses, and composed of ruby pieces.

Necessary Precautions to Ensure Sound Welds.—The carbons used should be uncoppered and of one uniform quality, sound and hard, and have a metallic ring when struck, and must burn with little or no dust deposits, otherwise the finely-divided carbon deposited on the weld may be absorbed by the metal, which will thereby be rendered brittle. When building up, the metal introduced into the weld should be as nearly as possible or the same composition as that of the article to which it is welded, and the workman should remove the slag formed on the surface of the weld from each layer added before commencing to add another one. In cases where the part to be built up projects above the neighbouring surface—as, for instance, a wheel tooth—each layer of material added should be retained in position and prevented from flowing away while in a molten state, and this is best done—previous to the addition of each layer—by forming a ridge of finely-ground gannister round the circumference of the layer to be added. When the metal in the vicinity of the arc has been under the action of the arc for a short space of time, the heat gradually extends by conduction to the metal in the neighbourhood of the part operated upon, whereby the resistance of the metal to the passage of the current is increased, and admits of a longer arc being obtained than under conditions where the metal in the vicinity of the part operated upon is not so heated. The workman should always endeavour to obtain these conditions of heating of the surrounding metal, and to finish off each layer under the action of a long and steady arc so as to ensure the gradual solidification of the metal added, and its subsequent annealing by the gradual radiation of the heat from the part operated upon, when the carbon is eventually withdrawn and the arc broken. In all cases where it is possible to do so each layer of new material added should be hammered immediately after the carbon is withdrawn and the arc broken, and where this is not possible the withdrawal of the carbon and breaking of the arc should be gradual.

The Deflected Arc System.

The field covered by the Benardos system just described, whilst being considerable, left something to be wished; for instance, repeated attempts have been made to make electric seam and lap welds, and to carry on operations of brazing and soldering. With the Benardos system this is impossible; it was therefore necessary to find other means than those hitherto employed. The heat of the electric arc is probably over 3,000deg. C., and with the Benardos system is concentrated on a small area. Simply because of the fact that the arc can only be formed between the carbon and the metal to be worked, all attempts to reduce the heat, and, secondly, to spread it over a larger surface, have failed. Dr. Zerener, of Berlin, saw the difficulty, and he has devised apparatus which is supplying the want hitherto felt in this last-named process. The dynamo mains are connected (through the usual regulating resistances) direct to two terminals very much after the fashion of an ordinary arc lamp with its regulating resistance in series. The current passes through the lamp connections to a carbon on the positive leg, jumps the air space, and returns to the dynamo through a negative carbon again, precisely similar to the arc lamp; but on each side of lamp an electromagnet is arranged which is energised by a portion of the main current being shunted through it, and in exact proportion to the current absorbed or rather required by the carbons. Thus, the moment current is switched on, a strong magnetic field is formed in which the arc is burning. This magnetic field effects the arc, and draws or spreads out the flame, and the extent of this drawing out can be adjusted at will. The members will at once note the difference between the two processes: in the latter, the welding apparatus is self-contained, and the article to be welded is not in any way in elec-

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trical connection with the dynamo, and the lamp may be raised or lowered, thus regulating the temperature of the heated article. These lamps are made in various sizes, the smallest one requiring only 27 amperes at 70 volts, or, roughly, 3 h.p.; it is capable of making 2,000 bicycle brazes in a week of 54 hours, and manipulated by one man. Up to a pressure of 75 amperes the lamps are held by the workman, over that current the apparatus is too heavy, and must be suspended over the work. The small lamps are adjusted by hand, the larger ones are automatic, and feed themselves in the manner of an arc lamp. The regulating resistance and other accessories are in every way similar to those used in the Benardos welding process.

Brazing.—A large variety of work has been accomplished in brazing copper tubes and flanges, copper to steel, brass to iron. Copper and zinc stampings as thin as 1-32in. have been successfully brazed without any running of the metal at junctions. Steel plate up to ¼in. thick, in the shape of barrels for carrying oil, petroleum, etc., water-cisterns, buckets, and other similar articles are electric brazed. Perhaps the most extensive application of electric brazing has been found in the cycle industry, where the work is most economically performed, from the fact that the plant can be run at practically normal load through the working hours.

Welding.—The chief application in welding up to the present time has been in seam welds on sheets or plates up to ½in. thick. Four boilers have recently been completed as a test for hot-water circulation for an American firm. The boilers were made of No. 14 gauge mild steel, they are 16in. in diameter, and 5ft. long; after the sheet has been formed into cylindrical shape, the longitudinal weld is made, the ends of the boiler are convex, and are welded to the shell. With a temporary appliance one boiler was completed in 55 minutes—viz., the longitudinal seam and two end welds; the current required was 230 amperes at 75 volts, and one man did the work. Steel pipes have been very successfully seam-welded for a length of about 10ft., having a diameter of 13in. and thickness of ¼in. A sample was tested with the following result: "Sample tested up to 450lb. per square inch, and, so far, appears perfect." Pipes varying from 1-16in. to ½in. in diameter have been made with equally good results. The seams are drawn up close, small pieces of mild steel are laid over the junction, and the process of welding goes on for some 6in., and when the fusion is perfect the joint is hammered. The rate of working is about the same in all thicknesses—viz,, about 1ft. in seven minutes. The current used varies, of course, with the thickness of the metal. A large plant has recently been erected in Hamburg for the manufacture of steel barrels, the capacity being equal to 100 barrels per week.

In conclusion, the writer begs to point out that this system of electric arc welding is not proposed as a substitute in all cases for the ordinary methods of welding now in use; nor is it proposed as a substitute for riveting in high-pressurse boilers, but rather as an additional method, capable of very extensive application, under conditions where the ordinary methods of welding are inapplicable. The simplicity of the process and the portability of the plant, combined with the large field where such a system would be most valuable, are certainly good reasons for a more extended use. It is perhaps impossible to conceive a more useful application for electric arc welding than the general requirements of a large colliery. All kinds of repairs can be made, as shown in the examples recorded in this paper. The apparatus is always available, and in many cases, there can be little doubt, would effect considerable saving in the promptness with which these repairs would be effected. It may perhaps be as well to again affirm the fact that welding and lighting can readily be arranged from the same generating plant.

THE TELEPHONE QUESTION.*

BY ALFRED R. BENNETT, M.I.E.E.

(Concluded from page 206.)

The want of agreement between partners is generally accepted as a proof of the weakness of their case. In this connection it is noteworthy that the evidence given by the Post Office and by the National Telephone Company before the late Select Committee did not always agree, and sometimes, even on essential points, was contradictory. The Post Office witnesses, in order to support their exaggerated estimates and to justify the high charges of the Department, laboured to convince the committee that as telephone exchanges grow, complications of the wires and switching apparatus increase out of all proportion to the additional number of subscribers, and that the cost of the switching apparatus especially increases in a ratio which, if it were true, would justify Mr. Arnold Morley's statement that the telephone can never be more than a luxury for the rich, since the growth of the exchange would soon render the cost of its extension prohibitive. If the committee had heard independent witnesses it would have been demonstrated that the Post Office figures are not justified by experience, which shows that the ratio of increase of cost in a properly laid out exchange is not notably out of proportion to the increase of subscribers' rentals. Mr. Forbes, speaking for the National Telephone Company, practically demolished this part of the Post Office evidence as he told the committee in explaining why the rate in Lancashire, which was originally £20 per annum, had been reduced, said that while the exchanges at Manchester, Warrington, Liverpool, etc., were in their infancy it was necessary to have a high rate, but that they grew rapidly and to such an extent that the directors saw their way to make a reduction to £15 per annum, and subsequently, after a further increase in the number of subscribers, to £10. According to the Post Office evidence, rates under such circumstances ought to have been increased, whereas the company adopted precisely the opposite plan and reduced them by 50 per cent.

Before the same committee the National Company deprecated competition as inimical to the interests of subscribers and the public generally, but then its preaching on this occasion differed widely from what has been its practice. For instance, Messrs. Tasker and Co. established their exchange in Sheffield, and held the town for many years without a rival; but in 1887, when Tasker's exchange was already a large one, the National Telephone Company commenced business in Sheffield, cut down rates to £5 for any distance, and notwithstanding its professions of solicitude for the public interest, deliberately inaugurated competition of the most active kind within the same area. That competition ultimately resulted in the acquisition of Tasker's exchange by the National Telephone Company, but Tasker, in giving up his business, made stipulations which have secured to the Sheffield public rates from that company (see my paper on "Municipal Telephony," read before the Northern Society of Electrical Engineers, November 11, 1895) which are lower than those enjoyed by any other town of corresponding importance. The Post Office opened an exchange in Cumberland; some months later the National Telephone Company commenced a competing system, and ultimately blotted out that of the Post Office. In Leicester, the Post Office opened an exchange, and connected to it nearly 200 subscribers; years afterwards the National Telephone Company commenced competition in Leicester at lower rates, and has now so reduced the Post Office exchange that only a remnant of some 20 subscribers is left to it. Other instances could be adduced in which the National Company has been the aggressor, and it would be interesting to learn how this fact can be reconciled with its present objection to competition. Is it not probable that this solicitude for the public interest has its origin in the fact that owing to the existence of its present monopoly the National Telephone Company must necessarily in the future be the attacked and not the attacker?

* Paper read before the East of Scotland Engineering Association at Edinburgh, February 5, 1896.

APPENDIX.

OPINIONS ON THE TELEPHONE QUESTION, EXPRESSED BY MR. F. E. BAINES, C.B.*

Extracted from his recent book, "On the Track of the Mail Coach" (Bentley and Co.).

The telephone, which I regret to see a statesman of weight regards as a luxury of the rich, is, from my point of view, a necessity of the poor. The public have little idea of its enormous social and commercial importance to all classes. Not in my opinion alone, but in that of persons who can speak authoritatively on the subject, is a telephonic exchange needed in every town and in every considerable village. A telephone made without the middleman costs but a few shillings; it need be no more expensive than a Waterbury watch. The annual cost of keeping up a mile of telephone wire ranges at the most from 25s. to 45s., and even allowing for the doubling of the wire, £3 would probably be an outside average. Perhaps even £2 a year per wire would in practice cover everything.

The prime necessity of a liberal extension of the telephone in the direction indicated I mention here, not as an original suggestion of my own. . . . It has been urged in a general way more than once by a member of Parliament who has for some years past directed public attention to details of postal economy, and it has been advocated in the public Press, and before a Select Committee of the House of Commons.

There would seem to be a general consensus of opinion that a liberal use of the telephone in rural districts would be of immense advantage to the State. How the telephone should be provided, by whom and under what conditions, may be matter of opinion, and is, in any case, of secondary importance. The primary object should be, by hook or by crook, to bring the telephone within the reach

* Late her Majesty's Inspector-General of Mails, and formerly Chief Controller of the Post Office Telegraphs; author of "Forty Years at the Post Office." Mr. Baines was first to formulate proposals for the acquisition of the telegraphs by the State.

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of everyone. But no insuperable difficulty occurs to me in the working out of such a scheme as is presented in this chapter by the Post Office in conjunction with any telephone company. A company would contract for, supply, and maintain telephone lines either on its own responsibility or as the agent of the Department, and to the advantage of both. Where the annual charge would be less than £5 purely local communications are in view. Where it would possibly be more than £5, communication through two exchanges is contemplated. In other words, telephonic communication from one part of a village to another part of it, or, similarly, from one part of a country town to another part of the same town, can be very cheaply provided and maintained. When a renter in the village requires the means of telephoning to a renter in a neighbouring town, and two exchanges are put in action, the cost is necessarily somewhat enhanced.

In time rich and populous England will learn a useful lesson from small and thinly-inhabited states—from Sweden and from Switzerland, from Denmark, and elsewhere, for already in Sweden the Government is about to combine the telephone with the State telegraph system. In that country everybody is stated to be "on the telephone." This is the key of the whole situation. England, whether urban or rural, would be a changed place—half its troubles would vanish—if that development were given to the telephone of which it is capable.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 27.

Dr. Hopkinson (President) in the chair.

At last night's meeting of the Institution the following candidates were balloted for:

Members.—Robert Stuart Hampson, Manchester, Sheffield, and Lincolnshire Railway Co., Guide Bridge, Manchester; Walter Osmond Rooper, Mill-street, Stafford; Major R. M. Ruck, R E., The Horse Guards, Whitehall, S.W.; David C. Smith, Oak-avenue, Elsternwick, Melbourne, Australia.

Associates.—John E. Addyman, 13, Sterne-street, Shepherd's Bush, W.; R. Stewart Bain, 25A, Cockspur-street, S.W.; Lawrence Birks, University College, London, W.C.; Walter Henry Cooke, 1, Bevois-terrace, Southampton; Arthur Thomas Cooper, Corporation Electricity Works, Blackpool; Oswald L. Falconar, Monkseaton, Newcastle-on-Tyne; Frederic Fowkes, Hawkstead, Ambleside; John George Freeman, 25A, Cockspur-street, S.W.; Sam. Handford, Ford House, Prestbury, near Macclesfield; Richard Hamerton Hayne, care of F. A. Glover and Co., Woolcomber-street, Dover; Charles Keeble, the Palatine Insurance Company, 101, Cheapside, E C.; Sidney Edward Linsell, 10, Corporation-street, Manchester; Arthur Richard Peart, Hanover Lodge, Chiswick; John Pilling, 90, John Brown-street, Bolton; Percy Speedy, 55, Victoria-street, S.W.; William Arthur Stevens, Maidstone, Kent; Walter Jeffrey Targett, 25A, Cockspur-street, S.W.; William A. Walton, London-road, Gloucester.

Students.—Leslie H. Andrews, 29, Lady Somerset-road, Highgate, N.; Ernest William Bache, Churchill House, West Bromwich; C. D. Braddon, Arc Works, Chelmsford: Arthur Daniel Crowther, Wardwick, Derby; Fred. Leslie Cruikshanks, 813, High-road, Tottenham, N.; Arthur Dangerfield, 292, High Holborn, W.C.; Charles W. Eden, 16, Peel-street, Nottingham; Allan Edgar Eyears, 34, Osborne-terrace, Westcombe Park, S.E.; William Ernest Few, Faraday House, Charing Cross-road, W.C.; Philip Henry Gibbs, 39, Lytton-road, Leytonstone, Essex; Ernest Joseph Greensmith, 49, Heathcote-street, Nottingham; H. C. Gridley, Moira House, Hampton Wick; William P. L. Harrison, Beaumond Cross, Newark-on-Trent; James Fitz-James McKean, Lanagh House, Castleblaney; Alfred Mitchell-Withers, 7, Woburn-place, W.C.; Austin H. Peake, Codnor, near Derby; Ernest Henry Rogers, Oakley Manor, Shrewsbury; Sydney John Roseblade, Glendale, Hamilton Drive, Nottingham; Charles B. H. Stalvies, Trent Bank, Wilford, Nottingham; Edward Ernest Tasker, 3, Cumberland-terrace, Lloyd square, W.C.; Robert Tervet, 54, Penshurst-road, South Hackney, N.E.; Thomas Julian Tolmé, 4, Salisbury-road, Wimbledon, S.W.; James Welford, 4, Beech-avenue, Sherwood Rise, Nottingham; F. H. Wilson, University College, Nottingham.

The **Secretary** announced that since the last meeting he had received from Mr. G. G. Ward, to be presented to the Institution, a very beautiful photograph of a picture lately presented to the New York Chamber of Commerce of the projectors of the Atlantic Cable.

On the proposition of the **Chairman**, a vote of thanks was accorded Mr. Ward for his gift.

The photograph, which was handsomely framed, was exhibited in the room.

The **Chairman** said, before they resumed the discussion on the papers by Mr. Bathurst and Mr. Sam. Mavor, he wished to state that it was important that they should get forward with their business that evening so that, at all events, they might get an abstract of Mr. Addenbrooke's paper dealt with. Therefore, he suggested that the speeches should be limited to five minutes. This was agreed to.

Mr. Binswanger dealt with the subject of the papers from the point of view held by the manufacturers. The question whether this or that system of wiring should be adopted for any installation was a question to be decided by the contractor. They, the manufacturers, had to find out what demand was likely to arise. Many contractors held the opinion that wiring in wood casing must some day or other be superseded. The material required for wood casing had had an enormous sale during the last 20 years, and at the present moment the cost was very low. To compare the cost of new installations proposed under the new methods with that of the old methods would, to his mind, be very unfair to the new methods. He could confidently predict that if either of the new systems proposed could have a fraction of the run that the old system had, the cost of the new one would compare very favourably with it. He urged simplicity of construction; they should use as few parts as possible in an installation. Why should they have to make different alternating-current motors, different alternating meters, and different alternating arc lamps simply because so many different frequencies existed in alternating stations? He concluded by suggesting that these questions should be well considered, and that a committee might be appointed by the Institution to give manufacturers some standard which he thought every manufacturer in England would be glad to adopt.

Mr. Boot said few of the members realised the enormity of the question at issue. So very much depended on wiring. It was no use their generating electricity if they could not use it in some more simple manner than was at present the case. Unless they adopted some system by which they could reduce everything to its lowest cost, he did not think they would do any good by adopting any fresh system. He, too, strongly urged simplicity of construction, which, he said, added to the merits of electricity. The great cost was in the labour, which they must reduce, and they must make the systems of wiring so simple that any ordinary man of intelligence could use them and put them up. His experience of concentric wiring was that it was not so cheap as regarded fittings as Mr. Mavor stated.

Mr. Rawlings pointed out what he considered the defect in the tubular system as exhibited by Mr. Bathurst—viz., that the tubes themselves were not flexible. Another very important point which they should remember was that they were not nail proof beneath the plaster. Testing did not find a nail unless it was in a damp place. He thought it was the duty of the Institution to stamp out the workmen who were going about—the scum of all the other trades—who called themselves wiremen. The Institution should have a method of registering men who should be supported by the members. He understood the City and Guilds Institute of London were doing something in this direction.

Mr. Human spoke from the point of view of the insurance inspectors, and devoted his remarks chiefly to a criticism of Major-General Webber's views. He admitted that many of the inspections were more or less a farce—four in nine of such inspections might well be dispensed with.

Mr. Shoolbred was very glad to see that in the table appended to his paper Mr. Bathurst had adopted an ampere test. The adoption of a lamp test was unsatisfactory, because there were not only 8-c.p. and 16-c.p. lamps, but motors and arcs to be considered. He had prepared a table on the subject, which he would hand to the secretary.

Mr. Dykes said the question of the best system of wiring was like the best engine or the best boiler—it entirely depended on circumstances of the case. Used with proper care as good insulation could be obtained with wood casing as with any other system, provided the building was suitable for it. If necessary, different systems might be used in different parts of the same house.

Mr. Crompton said it was a matter of regret that more had not been contributed to the discussion by those who had used concentric wiring.

Mr. Bathurst commenced his reply, and insisted that his system was really cheaper than wood casing. The greater part of his reply, however, he would not read, but would hand it in for publication, in order to allow of the reading of Mr. Addenbrooke's paper on high-voltage lamps, which was then proceeded with.

WHAT, WHEN, AND WHERE.

Physical Society.

February 28, 5 p.m.—At Burlington House. "Experiments with Incandescent Lamps," by Sir D. Salomons. "The Alternating-Current Arc," by Messrs. Fleming and Petavel.

Institution of Electrical Engineers.

March 4, 6 p.m.—Students' visit to the central stations of St. Pancras Vestry; meet at Stanhope-street central station, near Gower-street or Portland-road stations.

City and Guilds of London Institute.

March 5, 8 p.m.—At the Finsbury Technical College, Leonard-street, E.C. "Recent Discoveries in Electro-Optics," by Prof. Silvanus P. Thompson.

Society of Arts.

March 4, 8 p.m.—Thirteenth ordinary meeting. "Röntgen's Photography of the Invisible," by A. A. Campbell Swinton.

Electro-Harmonic Society.

February 28, 8 p.m.—At St. James's Hall Restaurant. Concert; ladies' night.

Carpenters' Hall Lectures.

March 4, 8 p.m.—At the Hall, London-wall. "Electricity in Connection with Building," by W. H. Preece, C.B.

Engineering Society.

March 6, 4 p.m.—At King's College, London. "Aluminium Extraction," by Mr. Hackman.

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THE TELEPHONE SERVICE.

The information elicited by Mr. Tully in the House of Commons on Monday, "that it is not the intention of the Government to take over the entire telephone service before the expiration of the present license," probably marks a new era in the telephonic history of the United Kingdom. The announcement, we have reason to know, has caused a flutter in certain quarters where the acquisition of the whole system by the Government at the next break in the license—December 31, 1897—has been looked forward to with considerable confidence. That expectation can no longer be entertained.

For reasons which we have from time to time placed before our readers, we have consistently recommended the Post Office as the only proper organisation to own and work the telephones. Admitting that the control of the telegraphs has been wisely vested in the Post Office, any other view appears illogical, seeing how closely the twin inventions are linked by their nature and practical applications. But the fiat has gone forth: it is not to be; and it behoves us to look the fact in the face, and examine with some degree of curiosity the vista which the new turn of the telephonic teetotum has opened up. From January 1, 1896, to December 31, 1911, the date of the expiry of the current license, is sixteen years. It is a long time. Within a like period the French Revolution sprung up, raged, decayed, and died. Is it expected that the present monopoly, undiluted, is to co-exist with the license? If so, we hasten to assure the authorities concerned that they are labouring under an error of no inconsiderable magnitude. Indications of rebellion against the "inefficiency and expensiveness," as Mr. Tully put it, of the National Telephone Company's service multiply apace. The city of Glasgow has renewed its demand for a license to construct and work a telephonic exchange system of its own, and Edinburgh, Aberdeen, and other Scottish towns are understood to entertain longings in the same direction. Nearly three thousand ratepayers of Manchester have expressed a desire for a municipal exchange, and although the movement has received a check, the existence of such a numerous body of malcontents is too significant to be ignored. Dover and other places are likewise in arms.

It is consequently certain that something more than a policy of quiescence must be forthcoming. The intimation that the Post Office itself will compete with its license in places where the existence of an unsatisfactory service can be demonstrated can only be regarded as of moment provided the Department is prepared to reduce its tariff by more than half. Mr. Tully's description of the present service comprises the word "expensiveness" as well as "inefficiency." Now, except in London, the National Telephone Company's charges, heavy as they are esteemed, nowhere approach the tariff for telephone exchange communication set up by the Post Office, and it seems to us ridiculous for the Department to say to a man who complains of having to pay £8 or £10 for a mile of wire, "Come over to our exchange; we will give you a

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metallic circuit and charge you—£14." A more common-sense view of the situation must, we are convinced, prevail. If the National Telephone Company, which is admittedly heavily over-capitalised, pays 6 per cent. dividends on £8 or £10 rates, the Post Office, with no such drawbacks, can surely flourish on rentals of £5 or £5. 10s. per annum. It is in evidence that more than one British telephone company has made ends meet on such charges as these, even when metallic circuits have been supplied; while on the Continent £5 per annum, and even less, rewards telephone undertakers with substantial profits.

If Post Office competition cannot be made to march with low rates it will meet with neither success nor tolerance, and, dismissing it from practical consideration, it will be necessary to clear the line for municipal or private enterprise, or both. Private undertakers will, however, have to be jealously watched and all possible safeguards against a repetition of the old absorbing and "water"-creating tactics imposed. There may be difficulties in framing a license so as to prevent transfers of business, but they are surely not insuperable.

We consider, therefore, that the Government's decision leaves but three paths logically open. These are: (1) maintenance of the existing monopoly; (2) active and business-like competition by the Post Office at reasonable rates; (3) issue of new licenses, under adequate guarantees, to municipalities and local companies. The first is impracticable unless public opinion is to be openly flouted and defied; the second, in view of Post Office lassitude in the past, is unlikely; the third appears, under the circumstances, the only reasonable solution.

The insignificance of the telephone industry at home as compared with the vast proportions which it has assumed in some other countries, constitutes a standing reproach to our national character for business intelligence and enterprise which we trust is now in a fair way to be wiped out.

RESULTS AT COLOGNE.

Elsewhere we give a brief account of the results obtained by the combined working of the waterworks and electric light station at Cologne. The two works, as well as the gasworks, are under the control of the Municipality. The buildings of the waterworks pumping station and the electric light station are close together, the new boiler-house serving either or both sets of engines. Of course, the circumstances at Cologne are exceptional; but there may be cases even in England where a similar combination might be beneficial. Messrs. Feldmann and Froitzheim point out the maximum output of the two works never coincides: "The largest consumption of water takes place during the day and the summer months; the maximum output of the electric station is attained in the evening and during the winter months. The boiler plant is therefore worked at a nearly constant rate of steam production throughout the year." This is a consummation desired by all electrical engineers, though the realisation is only for the few. There may be but a small number of places where the pumping plant is the complement of the electric light plant, and where extensive reservoirs do not intervene between the pumping plant and the mains; but the success at Cologne should, where possible, lead to a consideration of a similar combination. With all due respect to electrical engineers, we none of us really believe in a system which requires machinery for a maximum output for a couple of hours out of the twenty-four, and from 60 to 80 per cent. of which is idle during the remainder of the time. Interest and dividends may be paid, but that only proves the inherent value of the system of artificial illumination, and not the perfection of apparatus employed. The cry is, Add to the day load, level up the load curve, till the machinery is blessed with a constant load; but at present, with the exception of such places as Cologne, the blessing has not been attained.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RONTGEN RAYS.

SIR,—I do not remember having read anything referring to the following point in connection with the above subject.

It has occurred to me that possibly under powerful inductive influences the molecules of a body may undergo some rearrangement, perhaps a symmetrical or polar arrangement such as obtains in soft iron as a result of magnetic induction.

A body with its molecules thus arranged may allow certain rays to pass through it which it otherwise would not do, and possibly under these conditions the body would allow some of the rays of ordinary light to pass through it.

It has been stated, I believe, that the X rays are not refrangible, and are not, therefore, included in ordinary light rays; but is it not possible that some of the latter rays may refuse to undergo refraction?

Perhaps some of your readers can give some interesting information on these points.—Yours, etc.,

O. J. PRESTON.

COMBINED CABLING AND SERVING MACHINE.

Some time ago we promised our readers particulars of a machine of this description as supplied by Messrs. Johnson and Phillips, of Charlton, to H.M. Postal Telegraph Department for cabling their guttapercha-covered cables and at the same time serving them with compounded tape. This machine, which we now illustrate, is arranged for cabling seven wires—*i.e.*, laying six wires round one, and at the same time laying a yarn in the recess formed between each pair of wires, so that when the cable is taped it forms a more perfect round. The machine is erected on a strong cast-iron bedplate, and the six wire bobbins (arranged in two bays) are carried in forged wrought-iron flyers between three discs, the third disc also carrying the six yarn bobbins. The central hollow steel shaft runs in a large gunmetal stepped bearing at one end, and the "lay-head" end and the centre disc run on anti-friction rollers. The draw-gear is driven from the "lay-head" end of this shaft by means of a belt driving on to a countershaft carried from the bedplate of the machine. The motion is transmitted to the draw-through drum by means of spur and bevel gearing, change wheels being provided to give the requisite length of "lay" for the different sizes of wires. The taping head is designed to serve various widths of tapes, and for that purpose is driven by means of coned pulleys, which allow the "lay" and "lap" of the tape to be adjusted very minutely. The bobbin of tape, as will be seen, is arranged concentrically with the cable, the tape

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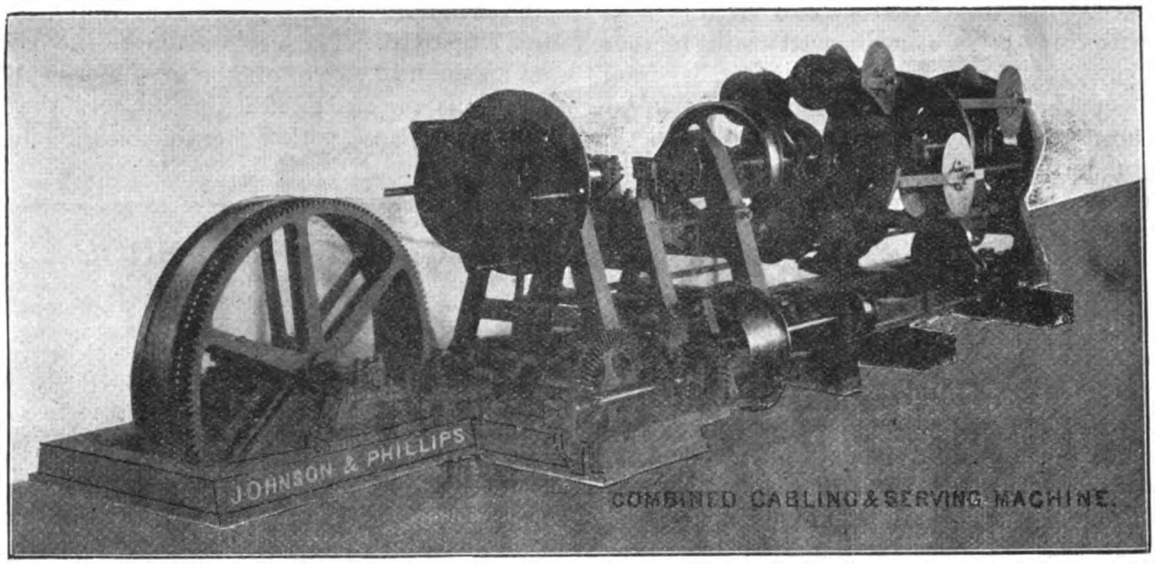
being led from the bobbin by means of a series of rollers, etc., down through a slotted guide on to the cable. The wire bobbins are each arranged to hold one mile of gutta-percha-covered wire, and the yarn and tape bobbins respectively hold sufficient tape to "worm" and "serve" this length of cable. The diameter of the tape bobbin is 21in.; the radius described by the taping head, measured over the guide-rollers, is 16in.; and the speed of this head is about 500 revolutions per minute. The central hollow shaft is 3in. diameter, and runs in large gunmetal stepped plummer blocks having bearings 2½ diameters long. All the bobbins are provided with means for adjusting the tension on the various wires, yarns, etc., as may be desired. The finished cable is led from the draw-through drum on to a receiving drum placed a few feet distant from the cabling machine, from which it is driven by means of a belt. This apparatus is provided with an automatic guiding-on and flaking gear, which is not shown in the illustration.



Besides the above-described machine, we understand that Messrs. Johnson and Phillips have supplied H.M. Postal Telegraph Department with a four-wire combined cabling and serving machine all complete with the necessary bobbin winders, swifts, and automatic winding and coiling gear for making the finished cable up into coils, and have fitted it up at the Mount Pleasant factory.

THE DEVELOPMENT OF ELECTRIC LIGHTING ENGINES.

BY H. LINDLEY.

This paper, which was read on Monday last before the Northern Society of Electrical Engineers, is an interesting account of the varous difficulties overcome in the development of high-speed engines. Mr. Lindley commenced by dividing electric lighting engines into three classes—viz., slow-speed, moderate-speed, and high-speed. The engines to which this paper refers are what may be called ordinary engines—viz., having cylinders, pistons, etc.—and the speed referred to is the speed of rotation of the crankshaft.

The author proceeded to point out that the piston speed in these three classes of engines mentioned does not vary much. The old method of choosing engines for a given work by trial and error was then discussed, with the improvements demanded by the Lancashire millowners. As soon as it became evident that electric lighting was likely to require the services of a large number of small-sized steam-engines, nearly every maker of them suddenly awoke to the fact that his particular make of engine was particularly suited for electric lighting work, and advertised the fact. The wish, however, was but father to the thought, and as soon as one of these engines was set to do the work that by calculation it should be equal to doing, and which also by exact calculation it was known to have to do, the crank-pin got hot. An extra large-sized lubricator was fitted to the crank-pin, and the engine was advertised as being specially designed and equipped for electric light work. But still it did not do. Why then did engine builders still persevere till they did produce an engine that would do the work it should do, when all the time there was the slow-speed mill engine waiting and willing to do it? The author's opinion was that, apart from other obvious reasons, there was the great question of cost; the slow-speed engine was too dear.

The author then discussed the modification introduced in the modern engines, such as the shortening of the stroke, the increased surface in the bearings, improved lubrication, the almost universal adoption of white metal in the bearings, etc. He also referred at length to troubles arising from the use of thin lock nuts for adjusting the big end bolts of the connecting-rods and the slide-valves, and to the mechanical details of the cross-heads and pistons.

Another point that deserved attention was the valve. That might be either of the flat or piston type. The flat valve had the advantage of cheapness and steam tightness, but it took more power to drive than the piston-valve, which was a consideration where automatic expansion by means of a shaft governor was used. The author then took up the important question of engine governing, and after careful consideration advocated a crankshaft governor on the grounds of safety and efficiency. He then returned to the question of speed, and explained that a high speed was a great advantage, and for the simple reason that direct communication with the dynamo was possible, and all other means of transmission were avoided. Although direct coupling was used with moderate-speed engines, the dynamos were then large and expensive. On account of centrifugal strains he did not think that any great increase in speed would be attained over the present practice.

The high-speed engine could, no doubt, be made very economical, if only on account of its high speed and the consequent higher temperature of its cylinder walls, but it was more susceptible to derangement from careless use, and if a breakdown of any part should occur the results would be more disastrous than in a slow-speed engine. Water, in particular, was a source of the greatest danger, and a separator was therefore usually fitted to that class of engine.

One point to which Mr. Lindley called attention in concluding the paper was that the electrical industry had created a demand for new and improved types of engine attendants, and that the old easy-going mill-engine tender, with hardly a care to trouble him, had in central electric light stations to give way to a man who was constantly on the watch lest anything should go wrong, and who was alive to the importance of maintaining a steady and uninterrupted working of the plant under his charge. Marine engineers knew what that meant better than those in charge of stationary engines; but the advent of high-speed steam and dynamo-electric machinery that must be kept going, had necessitated vastly increased watchfulness and care from those in charge, to what obtained only a few years ago.

The paper was well received, and is worthy of careful reading.

NOTES ON STEAM SUPERHEATING.*

BY WILLIAM H. PATCHELL.

Nature of Steam Superheating.—Superheated steam is steam of any pressure at a temperature higher than the temperature of its evaporation from water at that pressure. Saturated steam may be superheated by imparting additional heat to it at a constant pressure, during which process its volume increases. By permitting saturated steam of a given pressure to expand

* A paper read at the Institution of Mechanical Engineers. [We regret that we are obliged to condense this valuable paper.—ED. *E. E.*]

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without doing work superheated steam at a lower pressure may be formed. Steam cannot be superheated in the presence of the water from which it was evaporated, owing to the fact that the water takes up the heat and evaporates into further saturated steam. The corollary follows that water cannot exist in the presence of superheated steam; either the surplus heat in the steam will evaporate the water, or, if there be too little surplus heat to evaporate all the water, the steam will immediately become saturated by evaporating as much of the water as it can.

Messrs. Fairbairn and Tate, Hirn and Siemens, all found that saturated steam was not a true gas, but that when a temperature of about 20deg. F. above that of the saturated steam was reached the volume increased at about the same rate as that of a perfect gas. A marked feature in the use of superheated steam is the rapid fall in the superheat from radiation, etc. The reason of this more rapid fall in temperature as compared with saturated steam seems to be that the latter owes its heat-retaining properties to the water spray carried in it. It is only after this water spray has been evaporated that the steam becomes a true gas.

Aim of Superheating.—The greatest advantage to be gained by the use of superheated steam in engine cylinders is due to the immediate absorption of the film of water on the metal surfaces by the surplus heat, thereby counteracting cylinder condensation, which is the heaviest loss in the expansive working of steam. In this connection superheated steam would appear to have an advantage over steam-jackets, inasmuch as the heat is applied exactly where it is wanted, and during the period that it is wanted—that is, up to the point of cut-off—whereas a steam jacket wastes a considerable part of its heat n warming up the exhaust.

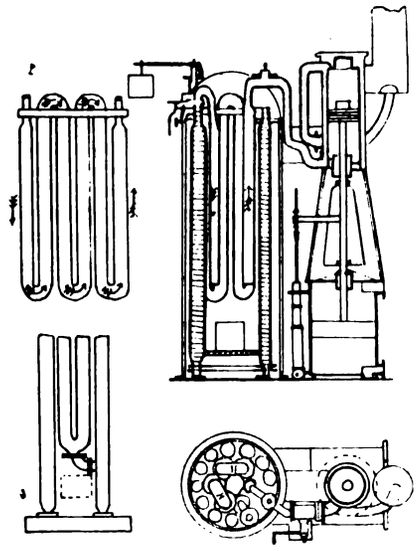

FIG. 1.—Trevithick Superheater.

Early Attempts at Superheating.—That economy attends the use of superheated steam in engine cylinders has been known at least since 1828, when Richard Trevithick reported on the engines at Binner Downs Mine in Cornwall. The engineer of the mine, Captain Gregor, built in his cylinders and steam-pipes with brickwork, making a fire-grate underneath them and flues around. The results were unexpected, and the duty of the engine was raised from 41 to 63 million foot-pounds per bushel (84lb.) of coal. Trevithick tested the 70in. cylinder engine, which when five bushels of coal was burned in 24 hours under the cylinder took 67 bushels under the boiler; when no coal was burned under the cylinder 108 bushels of coal was used under the boiler for the same work, showing a saving of one-third of the coal by superheating. The steam presssure was 45lb. per square inch, and the strokes eight per minute. Trevithick followed this up by inventing in 1832 a tubular boiler combined with a superheater between the boiler and the engine cylinder; he also jacketed the cylinder with the waste gases from the furnace. In Fig. 1 is shown the arrangement, copied from his patent No. 6,308 of 1832. The external series of vertical pipes, connected top and bottom to a hollow ring, constitute the boiler; the superheating pipes inside it are formed like inverted syphons, so as to avoid jointing at the lower end next the fire. Owing, doubtless, to the difficulty in controlling the temperature imparted to the steam, superheating made but little headway till 1850, when it came to the front again. Many plans were then proposed for superheaters and steam-driers in various forms, both attached to boiler flues and separately fired. Asbestos packings and brass bushes with plumbago plugs were then introduced to meet the demand for steam-tight glands under superheated steam.

More Recent Efforts.—Some results then obtained were reported to this institution by Mr. John Penn in 1859 (*Proceedings*, p. 195), followed by Mr. John N. Ryder in 1860 (p. 22). Mr. Penn described the apparatus employed by him in the Valetta steamer of the Peninsular and Oriental Company, with engines of 260 nominal horse-power, where the saving in fuel due to superheating was 20 per cent. Mr. John N. Ryder dealt with Messrs. Parson and Pilgrim's apparatus as fitted on marine boilers, and also Mr. David Patridge's superheater. The Parson and Pilgrim apparatus consisted of two horseshoe pipes fixed over the fire-grate in the internal flue of the boiler. Tests on the steamers "Osprey" and "Swift" showed a saving over saturated steam of 30 to 40 per cent. in fuel. Following closely on Mr. Ryder's paper was one read by the Hon. John Wethered, of the United States, at the Institution of Civil Engineers (*Proceedings*, 1860, vol. xix., p. 462), wherein he animadverted on the futility of the common kinds of superheater, and strongly advised mixed or combined steam, which he claimed to have introduced from America four years previously.

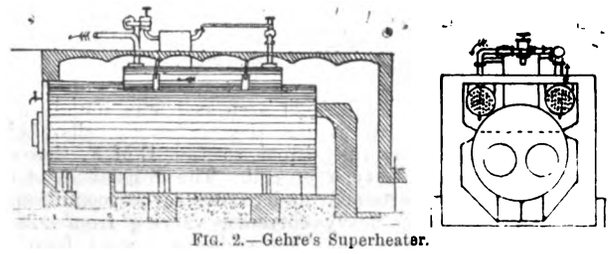

FIG. 2.—Gehre's Superheater.

Reasons for Former Abandonment.—If superheating was so common and of such manifest importance and efficiency in the saving of fuel some 40 years ago, the question arises why was it given up, and what factors that led to its abandonment have been eliminated in modern practice? Trouble was formerly experienced at the valve faces and in the cylinders from the decomposition and destruction, at the high temperatures of superheated steam, of the tallow and the low-class lubricants then in vogue. On this score, however, no trouble need now be anticipated at any degree of superheat likely to be attained where good hydrocarbon oils are used. Much of the trouble that has been attributed to the effects of superheat, in respect of cut cylinders and valve faces, has in the author's opinion been due in reality to the effect of alternate superheat and water in the steam, owing to want of proper control of the superheaters. The majority of the old troubles were met with in the engines; but the superheaters themselves do not appear to have been always above reproach.

Reintroduction of Superheating Apparatus. — Concurrently with the increased efficiencies gained in late years in both boilers and engines, competition has also increased; and with it has arisen the continual cry for cheaper power, cheaper transport, cheaper means of production. The result is that engineers cannot afford to dismiss without careful examination the claims of any plan the adoption of which may diminish their consumption of fuel. It is this fact which has again brought superheating to the front, and has made it the subject of close enquiry in many quarters. Several kinds of superheater are now in more or less extensive use; but only one of them is a radical departure from those of 40 years ago. Any change in the others is rather in manufacture than in design.

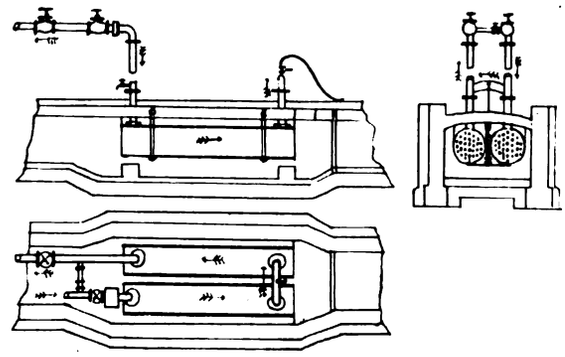

FIG. 3.—Gehre's Superheater

Gehre's Superheater.—This is in extensive use on the Continent, and has been introduced into this country by Messrs. B. Donkin and Co., of Bermondsey. It is shown in Figs. 2 and 3, and may be either fitted in the boiler flue or separately fired. Mr. Bryan Donkin kindly gave the author a copy of a test made in Germany, of eight hours' duration, on a water-tube boiler with and without the superheater. The heating surface of the boiler was 861 square feet, and of the superheater 646 square feet. The superheater was placed directly behind the boiler in a special flue. The result of the tests, which were carried out at 110lb. pressure, show a saving of 34 per cent. of coal, but 5 per cent. more steam was used on the trial without the superheater.

(To be continued.)

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DR. LESSING'S DRY BATTERY.

The following is abstracted from reports by Dr. R. Mullineux Walmsley, F.R.S.E., M.I.E.E., on tests made on the Lessing battery :

Dr. Lessing's cells belong to the well-known type of modified Leclanché cells, the depolariser being black oxide of manganese and the exciting fluid sal-ammoniac. Each cell is contained in a neat porcelain outer cylinder or jar highly glazed, and is securely sealed up. Lugs on the carbon and zinc plates project through the seal, and are provided with convenient binding screws for making connections. The height of each cell is 6·3in., and its external diameter 3·1in., whilst the weight averages about 3lb. 2oz. The arrangements for so sealing the cell that the moisture cannot creep or escape, and the necessary vent for the gases that may be set free, appear to be admirably adapted to the objects in view, and have responded very well to the preliminary tests. Further tests designed to break down these arrangements tried them still more severely.

The tests were made upon three cells taken at random from a large parcel. The E.M.F. of each cell was found to be 1·470 volts, the variations on the different cells being inappreciable. This is fully equal to the E.M.F. that can be expected from this type of cell. The resistances of the cells were next ascertained under very severe conditions—viz., when generating heavy currents, varying from 2·25 to as much as 3·75 amperes. The resistances were found to have the following very low values for the above size of cell: No. 1 cell = ·222 ohm, No. 2 cell = ·166 ohm, No. 3 cell = ·121 ohm. Each resistance given is the mean of four measurements taken with currents varying within the above-named limits.

The cells were then discharged in series through a constant external resistance for 45 hours continuously, the currents given varying from 113 milliamperes at the start to 36 milliamperes at the end of the test. These currents are much larger than the cells would ordinarily be called upon to give, and the fact that they were maintained for such a long period without the cells being allowed to recuperate by intervals of rest augurs well for the practical use of the cells. Measurements of E.M.F. and resistance were made at intervals during the discharge. The details need not be given in this preliminary note, but it may be stated that at the end the E.M.F.'s were 76·2, 78·7, and 74·7 per cent. of their respective values at the beginning of the test, whilst the average resistance had only risen to a little over 0·4 ohm per cell.

The cells were next allowed to rest for five days, during which the E.M.F.'s returned to 99·0, 99·4, and 92·9 per cent. respectively of the before-named initial values. On discharging continuously for a further period of 24 hours through the same resistance as before, the current fell from 108 milliamperes at the start to 80 milliamperes at the end of the time. Simultaneously the E.M.F.'s had fallen to 72·3, 74·0, and 68·8 per cent. respectively of the value at the commencement of the first test.

In the next test three cells were discharged through a constant external resistance, which was such that the current at starting was 435 milliamperes, a very large current to take from cells of this size. Notwithstanding this, the cells maintained the current for rather more than six hours, during which time the fall of the current was less than 7 per cent. Shortly afterwards the cells fell off very rapidly, but their resistance at the end of the six hours was less than 0·2 ohm per cell.

Three fresh cells were then discharged through a larger constant external resistance, such that the value of the current, after the cells had been at work a few minutes, was 42·5 milliamperes, a value approximating to the currents usually required from cells of this kind. At 27·2 hours from the commencement of the test the current had fallen to 39·4 milliamperes (92·7 per cent. of the above starting value); at 48·7 hours it was still 39·4 milliamperes; at 71·1 hours it had fallen to 37·3 (87·7 per cent.); and at 95·5 hours to 27·6 milliamperes. This last low value was due to the fact that one of the cells had become exhausted. This cell was, therefore, now cut out of circuit and the external resistance reduced to two-thirds of its value for the three cells. The current from the two cells then rose to 37·6 milliamperes (88·5 per cent. of the first value), and only fell to 26 milliamperes at 170 hours from the start. The two cells were now practically equal in E.M.F. and resistance, and though the discharge was continued for nearly 22 hours longer it is unnecessary to quote further measurements, as for all practical purposes the cells were exhausted.

In the set of tests now being described the resistance was less than 0·2 ohm for each cell at starting, and remained at that value for over 24 hours. It then began to rise irregularly and in different ways in each cell till at the end of 48 hours it was about 0·5 ohm per cell. At the end of 72 hours it had fallen in two cells, but had risen to over one ohm in the third, which was the cell cut out 24 hours later. In a general way, it may be said that the resistance fluctuated about the value of 0·5 ohm per cell until the cells were exhausted, and that the rise of resistance was a sign of approaching exhaustion more marked at first than the fall of E.M.F.

Further tests showed that with cells in good condition currents of from 25 to 28 milliamperes may be taken continuously and without breaking circuit for 260 hours or longer, a result which may certainly be regarded as very satisfactory.

Intermittent-Current Tests.—One of the chief uses of this type of battery is not for the supply of continuous currents, but for generating intermittent currents. It was therefore desirable to examine the behaviour of the cells when supplying such currents, but still under conditions more rigorous than would probably be exacted in actual practice. A piece of simple apparatus driven by clockwork, but which it is unnecessary to describe in detail, was therefore constructed, by which the circuit of a battery could be kept closed for four minutes, and then opened for the six following minutes, to be again closed for four minutes and opened for six, and so on for as long as was considered desirable. Two tests were made with this apparatus with different internal conditions. The results were as follows: In the first series the cells were allowed to discharge through a constant external resistance, such that the current at the end of the second four minutes was 258 milliamperes—a heavy current to take from such a battery for any extended period. The tests were continued for 96 hours. Before any current had been taken from the cells their E.M.F.'s were 1·505, 1·490, and 1·476 volts respectively, and the resistances after the above current had flowed for a few minutes were 0·54, 0·49, and 0·10 ohm respectively. At the end of 49 hours the E.M.F.'s had fallen to 79·8, 78·8, and 83·0 per cent. of their initial values, whilst the resistances had increased some 50 per cent.; at the end of the 96 hours the E.M.F.'s were 71·0, 62·7, and 52 per cent. of their initial values. It is evident that at this time the battery was practically exhausted for this method of working.

In the second test the resistance was such that the commencing current was 27·6 milliamperes. At the end of 167½ hours, throughout which currents of four minutes' duration were followed by rest intervals of six minutes, the current had only fallen to 26·4 milliamperes. The cells were next allowed to rest for some days and were then again discharged through the same resistance. The current started at 27·2 milliamperes, and at the end of 213·4 hours' further work had only fallen to 25·0 milliamperes. Thus, after 380 hours of intermittent working, the current from the three cells through a constant resistance had only fallen 9·6 per cent. of its initial value.

Comparing, however, with the corresponding continuous-current tests, we find that about the same percentage fall of current occurred after 308 hours' intermittent working as after 70 hours' continuous working. In 308 hours the current is actually on for 123 hours. Now, in the "continuous" tests the cells continued to give a good current for about 280 hours, or 4 × 70. If we assume the proportion to hold, it would have taken 1,200 consecutive hours to exhaust the cells by the intermittent working. The calculation, though on a probable basis, must only be taken as approximate. Returning to the "intermittent" tests, it was found that the percentage fall of E.M.F. was fractionally (but very slightly) greater than the fall of current, because of the falling off in resistance referred to below.

The above tests show conclusively that these cells are admirably adapted for generating intermittent currents of the magnitude usually required for many purposes, such as telegraphy, telephony, ringing electric bells, and for medical and other uses. The cells, for their size, have, as a rule, a very low internal resistance, and consequently a high efficiency, since only a small proportion of the electric energy is lost in working against the internal resistance. They also have good recuperative power, and if the outside be kept dry the terminals are very well insulated.

One other important property of Dr. Lessing's cells may be referred to in conclusion. Throughout the tests, even when the heaviest continuous currents were being taken, in no instance did a cell show any sign of bursting or of mechanical leakage. In this respect they compare favourably with some similar cells on the market which the writer has seen burst open by the expansion of the materials caused by the heat generated by heavy currents.

Dr. Walmsley concludes the report by acknowledging the help of three of his students (Messrs. J. H. Hughes, C. A. Henderson, and M. Thomson) at the Heriot-Watt College, for the care taken in making the experiments, and to the two first-named for constructing the special apparatus required for the intermittent tests.

The agents for the battery in this country are Messrs. Krupka and Jacoby, 15, Queen-street, E.C.

THE PHYSICAL SOCIETY.

The annual general meeting of this society was held on the 14th inst., Captain W. de W. Abney, president, in the chair.

After a discussion on the financial status of the society, the officers and council for the ensuing year were elected as follow: President; Captain W. de W. Abney, R.E., C.B., D.C.L.,

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F.R.S. Vice presidents: Mr. Shelford Bidwell, M.A., LL B, F.R.S.; Major-General E. R Festing, R E., F.R S; Prof. J. Perry, D.Sc., F.R S; Mr. G. Johnstone Stoney, M.A., F.R.S Secretaries: Messrs. T. H. Blakesley, M.A., M.I.C E, 3, Eliot-hill, Lewisham, S E, and H. M. Elder, 50, City-road, E C. Treasurer: Dr. E Atkinson, Camberley, Surrey. Demonstrator: Mr. C. Vernon Boys F.R.S The other members of council are: Messrs. Walter Baily, M.A., C. V. Burton, D Sc., L Fletcher, M A., F.R.S. R. T. Glazebrook M A, F.R.S., and Prof. A. Gray, M.A., Mr. G. Griffith, M.A., Profs G. M Minchin, M A., F.R S., W. Ramsay, Ph.D., F.R.S, S. P. Thompson, D.Sc., F.R S, and S. Young, D.Sc., F.R S.

The **Chairman** having read an obituary notice of the late Right Hon. T. H. Huxley, the meeting was resolved into an ordinary science meeting, and a paper on "**The Determination of High Temperatures by the Meldometer,**" by **Prof. Ramsay** and **Mr. Eumorfopoulos**, was read by the latter. The meldometer, an instrument invented by Dr. Joly, of Dublin, consists essentially of a thin platinum strip which can be heated by the passage of an electric current. Small fragments of a solid substance are placed on the platinum strip, and the temperature at which they melt is deduced from the length of the platinum strip, which has been previously calibrated by means of solids of known melting point. The authors have used gold for the purpose of calibrating the strip, and have assumed Violle's value—1,045deg. C.—for the melting point. A number of measurements have been made of the melting point of salts of sodium, lithium, strontium, barium, calcium, and lead The results obtained, however, differ considerably from those of Haycock and Neville, and the authors have not been able to account for these differences.

Prof. Ramsay said the chief advantage of the meldometer was that only a very minute fragment of the substance was required for the measurement, so that extreme purity of the sample could be secured. There was the disadvantage, however, that many substances underwent some change when heated in air. In reply to a question from Mr. Blakesley, Prof. Ramsay said that the property of the platinum which was used to measure the temperature was its expansion.

Mr. Campbell asked whether the zero of the instrument was found to be constant. In Cardew voltmeters it often took several hours for the needle to come back to zero after heating.

Mr. Eumorfopoulos, in reply, said that the zero was constant to within ½deg.

COMPANIES' MEETINGS AND REPORTS.

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LIMITED.

The annual general meeting of this Company was held on Friday last at Winchester House, E.C., Sir David Salomons, chairman of the Company, presiding.

The **Chairman**, in moving the adoption of the report and accounts (a copy of which appeared in our last issue), remarked that 3½ years had barely gone over their heads since the Company had started. It was in September, 1892, that they took over the pioneer company, with its unexpended capital and a few street lamps erected in Queen Victoria-street and other parts of the City, but no private lamps. By the end of that year, however, they had connected and were supplying with current 20,000 private lamps with the pioneer company's machinery. During the first two years the demand for lamps was so great that they had considerable difficulty in meeting it, and, besides, they were placed at the disadvantage of having to learn the peculiarities of the district they supplied. This experience had now been obtained, and they were able to tell almost from hour to hour what was likely to be required of their plant. The first two years might properly be regarded as the construction period, and although the whole of their machinery was not yet in place, they were in a very different position last year from what they were in the two preceding years. At the present time they had under one roof the largest installation in existence, and he had every reason to believe it was of a thoroughly satisfactory character. Their machinery would be no longer working under the disadvantages of a temporary roof and the dust and dirt incidental to unfinished buildings. From the support they had received there would be no doubt that the Company would be a success, and it might now be regarded as established upon a thoroughly sound basis. With reference to their treatment of the depreciation fund, the strength of their position was that they had done work which could not earn them any money during the year, but which rendered it certain that they would be able next year to meet the parliamentary depreciation fund without calling upon their premiums again, and would probably have a surplus over. They had erected a much larger installation than had been as yet taken advantage of and it would be scarcely fair to charge the whole of the depreciation of that installation to the profits of a single year. The money had not been spent, but only transferred so as to meet the parliamentary requirements. After referring to further items in the accounts, the Chairman said the question of the telephone tubes was gradually settling itself. Owing to the great demand for the supply of current in the City it had been necessary to use a good many of these tubes for their wires, but they had still some they would be pleased to sell or lease to the Telephone Company. But for these tubes it might have been necessary to open the streets a second time. An action against the Company for vibration had been settled by the purchase of the property out of which the complaint arose, and every effort was made to prevent annoyance to their neighbours at the generating station. As to a suggestion which had been made by certain shareholders respecting the payment of an interim dividend on the ordinary shares, he said that at present the directors were unable to adopt such a course, and he himself thought it might be some years before such a proceeding would be thoroughly safe so far as the ordinary shares were concerned. Their accounts were made up to December 31, and it would be very inconvenient if, after paying a dividend on the first half-year, they subsequently discovered that it had not been earned. In electric light working the second half-year was a better one than the first. The Board, however, realised that the shareholders might desire to know how the Company was progressing, and the Board would therefore be quite willing to issue to them a circular giving that information at the half-year. It was proposed to increase the auditors' fee from 100 guineas to 125 guineas, and he might say that suggestion had come from the Board, and not from the auditors.

The **Earl of Suffolk and Berkshire** seconded the adoption of the report.

Mr. Waller asked if anything had been done as to lighting the lesser streets of the City; and **Mr. Herring** pressed the subject of an interim dividend, as to which some conversation followed.

In reply the **Chairman** said that, as he had explained, fixed charges and other expenses absorbed nearly all the money earned during the first six months, and that their dividend was really earned in the second half of the year. The question of lighting the minor streets of the City was still under consideration. Their engineer (Mr. Bailey) was in negotiation with the City authorities on the subject, and the Board were anxious to get the contract settled.

The resolution was then carried unanimously, as well as formal resolutions for the dividends at the rate of 6 per cent. on the preference and 5 per cent. on the ordinary shares for the year.

A motion to change the hour of the general meeting from 2.30 to 12.30 was lost, and the retiring directors and auditors having been re-elected the meeting ended with the usual votes of thanks.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION, LIMITED.

The annual general meeting of this Company was held on Monday at 2, Craig's-court, W.C., Mr. G. H. Brougham Glasier, chairman of the Company, presiding.

The **Chairman**, in moving the adoption of the report and accounts a copy of which appeared in our last issue, said that if shareholders compared these with the accounts of the previous year they would find that their business had been a continually prosperous one. In all items where a decrease of expenditure was desirable there had been a decrease, and as regards the output of the Company the increase had been a most satisfactory one. The actual increase in their business was equal to 25 per cent. of the number of lamps supplied, and in this respect it had almost doubled itself in the past two years. As they were aware, the price per unit had been reduced, but no doubt this reduction had commended itself to their consumers, and was not without its influence in the popularising of the light. One point about the Company's supply the speaker called attention to was the regularity of the pressure maintained; their pressure did not jump about as did some of the London supply companies, and it was very satisfactory to the Charing Cross Company to find it so. This was a matter of very great importance in connection with electric lighting, because if the pressure jumped about, not only was the light uncertain, but the lamps would not stand for so long. Notwithstanding the competition they had had to contend with, not a single customer had left them to go to their competitors. The station had been maintained in a high condition of efficiency. Out of the past year's earnings they had transferred £3,000 to depreciation account, which now amounted to £5,300. This transfer had had to be made, to comply with the Board of Trade regulations, before arriving at their net revenue With regard to the provisional order which they had applied for, for a very much larger area, it was granted by the Board of Trade, and their Bill for confirming the grant passed the House of Lords last year. Owing, however, to the dissolution of Parliament, it did not get into the House of Commons, but he believed that it would be in that House in about a fortnight. They had had to meet rather strenuous opposition in connection with it from the Metropolitan Company, but they had little doubt they would obtain their Bill. They wanted more room in order to be able to deal properly with the amount of electric energy they had to supply, and they had obtained new premises in Commercial-road, Lambeth. These occupied an area of nearly three-quarters of an acre. The site was a very eligible one for a generating station, as it had a river frontage, so they would be able to deliver their coal and other things alongside, and they anticipated that they would be able to effect a saving in the cost of production. The Chairman then moved the resolution for the report, accounts, and payment of a dividend of 6 per cent. for the half-year, making with the interim dividend, a payment of 5 per cent. on the year.

Mr. Hillhouse seconded the resolution.

In reply to questions from shareholders, the **Chairman** added that the Board did not at present know what the expenditure would be in connection with the new station, but it would be kept down to the lowest possible sum, having due regard to the efficiency and stability of the work. They had arranged for the new capital they would require to be advanced at 4 per cent., and they would receive the money from time to time as it was wanted, so that a large sum would not be lying idle. As to the conversion of the

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debentures, it was not possible to do anything until the term of the debentures expired. That would be in 1900, and they had no doubt that they would then be able to pay them off and get any money they wanted for much less than 5 per cent. The percentage of cost of generation and distribution to revenue in 1894 was 50 per cent., but in the past year it was reduced to 45 per cent The information asked for was published every week.

The resolution was then carried unanimously, as was one for the reappointment of the retiring directors, and the meeting concluded with the usual vote of thanks, special mention being made in the latter of Mr. Patchell, the engineer.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY, LIMITED.

The ninth ordinary general meeting was held on February 20 at 1, Great George-street, Westminster, Mr. Granville R. Ryder presiding.

The **Chairman**, in moving the adoption of the report and accounts, said he thought they afforded evidence that there was plenty of vitality in the Company, and that its progress was steady and continuous. During the year their main mileage had been increased by a mile and a quarter, making a total of 20 miles. The houses and shops connected had increased from 908 to 1,109, the lamps supplied by the Company from 80,678 to 94,780, and the sale of electricity from 977,789 units to 1,228,734. The net profit had increased from £9,289 to £10,988. The debenture debt had been converted from 4½ per cent. first mortgage debentures to 4 per cent. debenture stock, the debentures being paid off at £105 by new stock issued to the holders. With part of the proceeds freehold premises close to the Company's central station at Knightsbridge had been acquired, which would be of very great advantage in connection with the working of the station. The total capital expenditure during the year was over £20,000, of which £7,350 was for engines, dynamos, and boilers. £1,351 for meters, £4,442 for mains, and £1,121 for batteries. The sum of £1,000 had been written off the goodwill account, and the renewal account had been strengthened by the addition of £4,270, making the total amount placed to that account £9,990

Mr. G. H. Hopkinson seconded the motion, and the report was adopted.

A final dividend at the rate of 7 per cent. was declared on the ordinary shares, making, with the interim dividend. 6 per cent for the year.

Messrs. G. R. Ryder and A S. Bolton were re-elected directors, and the auditors were also re-elected.

NOTTING HILL ELECTRIC LIGHTING COMPANY, LIMITED.

The annual general meeting of this Company was held on Tuesday at the Company's offices, Bulmer-place, Notting Hill-gate, Mr. Sidney Waters presiding.

The **Chairman**. in moving the adoption of the report and accounts, a copy of which was given in our last week's issue, first briefly referred to the absence of Mr Crookes (the chairman of the Company) in South Africa, and said that the resolution to be submitted would be also for the declaration of the dividend of 6 per cent. on the preference shares and 2 per cent. on the ordinary shares. Referring to the accounts, he remarked that it was a matter for congratulation that the future of the Company was regarded with such confidence that they had been able to issue their preference shares at a premium, and they had applied those premiums to the reduction of the preliminary expenses account. The new accumulator had been necessitated by the expanding business of the Company. It had been built by the side of the original one, and with connections had cost £1,818. Mains had cost £2,489, two-thirds of which sum was for laying the mains along Addison-road and extensions in the neighbourhood, and the balance was for small extensions. With regard to the contemplated second central station in the neighbourhood of Addison-road, it had neither appeared that the revenue likely to be derived from it would justify the outlay, nor was a suitable site to be obtained. Under the advice of their engineer (Mr. Schultz) the Board decided to supply the district from their central station, although it was more than a mile distant. This had been in every way a success. The concentration of work under one roof had proved economical, and the supply of current was perfectly satisfactory, while the demand had shown clearly that a second station, if it had been erected, could not have paid for years. In reference to the revenue account. there had been a satisfactory increase due to sale of current—182,327 units being sold, as against 130,266 in the previous year. The expenditure upon the accumulators had been charged to revenue instead of taken from the depreciation and renewal fund. The directors proposed to draw £400 for their fees, as against £300 in the previous year, in place of the £1,000 to which they were entitled. The depreciation fund stood at £1,300, and it was the policy of the Board to increase it to such an extent that the Company would be able to meet any accident or breakdown that might happen without inflicting on the shareholders a loss of their dividend. The only mischance that had happened to them during the year had been due to the water companies' pipes bursting during the great frost. This had caused the flooding of three of their culverts, but although there was necessarily a loss of a certain amount of current, he was pleased to say none of their customers were deprived of their light, and the Company had not failed to keep up the proper standard of pressure. In view of a similar occurrence in the future, additional drains had been put in. Considering their district, the business of the Company was increasing at a satisfactory rate, and it would be seen from the diagram prepared that though the current taken varied from month to month, each month showed an increase over the corresponding month of the previous year. This expansion would doubtless continue, but its rate would be dependent upon the improved prospects of finance, since when times were bad people avoided the outlay necessary for wiring their houses. There was a fair amount of new building in their district, and the use of electricity was also likely to increase for other purposes, such as for cooking, for advertisements, and, when adverse legislation was removed, for road carriages. As soon as their Bill was passed they would proceed energetically with their northern area, and an important part of the extensions would be the trunk line to be laid down Holland Park-avenue, which would complete the Addison road system, from the Uxbridge-road. The value of the current consumed per lamp, though higher than last year, was still less than that of other London companies; but it must be remembered that their district contained no clubs and theatres and buildings of that kind, and comparatively few shops. It followed that great caution must be exercised before deciding to reduce the price of their current. They had made many extensions which only just paid their way, and in the past year 81 new installations had required 23 extensions. They had, however, a scheme of rebates giving a slight reduction to those who burned their lamps for a greater number of hours, and in future they might consider the practicability of a further extension of that system. Their customers might rely upon it that, besides giving them a light which was perfectly steady, the Board would consider what could be done to reduce its cost at the earliest period that it was safe to do so. It might be added that, in view of fires which had occurred at central stations, the Board had effected an insurance on their revenue in case of such a disaster occurring. Their assessments had been increased, but they had been advised not to appeal.

Mr. E. Franklin seconded the resolution, remarking that there was one matter of a personal nature which the chairman had left to him to refer to, and that was that as a mere act of justice they should acknowledge the energy and exertions of their engineer, Mr. Schultz, whose spare time appeared to be occupied in working out schemes for the benefit of the Company. With reference to the office staff, when they were informed that out of a revenue of some thousands there was now left due only about £13, shareholders would see how their staff did their duty. It had not been customary to pass a formal vote of thanks, but he thought this acknowledgment was justified.

The retiring directors (Messrs. Waters and Crookes) and the auditors were then re-elected, and, in acknowledging his re-election, the **Chairman** said that, having watched over the Company from its infancy, he now began to feel proud of its progress. Its future seemed now to be thoroughly assured.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED.

The annual general meeting of this Company was held last week at the Company's central station, Richmond-road, Kensington, Mr. W. Page presiding.

In moving the adoption of the report and accounts, a copy of which appeared in our last issue, the **Chairman** said the increase in the lights connected during the past year was equivalent to 8,304 8-c.p. lamps, bringing up the total number to 44,162. The revenue had gone up from £5,010 in 1890 to £15,394 in 1894, and it was still increasing. In the first six weeks of 1894 the applications for connection numbered 831, while during the same period of the current year there had been 1,420 applications. In 1892, 1893, and 1894, although the output was greatly increased, the expenditure was kept quite steady, but in the past year it had been larger. There were several causes for this which he anticipated would not occur again. During the last week or two, since they had to some extent modified their working arrangement and substituted new plant for that of an older type, a considerable saving had been effected in coal. Although theirs was an entirely residential district, he believed that when they got their number of lights sufficiently increased the undertaking would prove to be much more profitable than it was at present.

Mr. R. A. Germaine seconded the adoption of the report. The motion was carried, and was followed by a resolution for the payment of the remainder of the dividend on the 7 per cent. cumulative preference shares.

NATIONAL TELEPHONE COMPANY.

The seventeenth ordinary general meeting of the National Telephone Company, Limited, was held last week at the Cannon-street Hotel, E.C., Mr. J. Staats Forbes (the president of the Company) in the chair.

The **Chairman**, in moving the adoption of the report, said there had been during the half year a comparative increase of £43,680, or 11·55 per cent., in income, and in working expenses the increase was £11,344, or 5·52 per cent. The net result of the half-year was a profit of £167,873, or an increase of £29,230 on the corresponding half of last year. They were able to report progress in all directions. With reference to the dividend of 6 per cent., he stated that they must bear in mind that they had to face competitions and combinations. They had had to deal with the New Telephone Company and the Mutual Telephone Company, which were got up and run in order to be bought off, and therefore they thought

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it prudent, after discounting the agitations against them, and taking into consideration the expansion and advantages of their business, to give the shareholders the benefit of an extra ½ per cent. dividend. The agreement with the Post Office with regard to trunk wires had been completed and the Company were now waiting to be paid. They hoped to be able to work amicably with the Postmaster General, to the interest of the public, and their own benefit, and they had no doubt that by hook or crook the trunk wire telephone business would increase enormously in its social and commercial value. The National Telephone Company must depend more or less on its universality. The amount they had to receive from the Treasury was considerable and equitable, but for the present it was not desirable to make the figures public. He did not propose to offer any criticism upon the competition which was talked about, and the fallacies which had been spread broadcast. Comparisons had been made as to what could be done in Stockholm; but it should be remembered that house-rent and all domestic expenses were on a very low scale there, and no doubt the charge for telephonic communication would be somewhat in proportion to the standard of values It was easy when they came to meet these suggestions by the dreadful process of reducing them to facts and figures to show how fallacious they were. Up to a comparatively recent period the telephone was an experiment, and for a number of years people would not take it seriously. Now, however, that was all changed. The Company had now 82,093 subscribers, and these people were coming in year by year at the rate of 8,000 or 9,000, so that the Company had to find large amounts of capital in order to take them on. The maximum charge was now £17, with reductions on every additional wire. The Company had spent £337,905 in the year 1895 in order to meet the demands of the 8,740 new subscribers, which worked out at an average of £38. 13s. 2d. The Company had been at work for a great number of years doing this sort of thing. In reference to the accounts, the most important item in the balance sheet was the reserve fund, made up of amount reserved from profits £279,545, and premium accounts, £36,804, or a total of £315,630 On the other hand, they had a large stock of materials, amounting to £204,853. He wished this item had been less; but if distributed in tools, wires and instruments all over the country it became comparatively insignificant. The Chairman concluded by referring in feeling terms to the loss sustained by the Company in the death of Sir Henry G. Calcraft, K.C.B.

The **Right Hon. Lord Harris** seconded the resolution, remarking that even public criticism was a good thing, for in the end it must come down to a matter of £ s. d. He found from the Government returns that the Post Office was carried on at a substantial profit, and surely the same privilege should not be denied to private persons who had ventured their money in such a magnificent service as the telephone service now was.

The resolution was carried unanimously, and on the motion of **Mr. Chapman**, seconded by **Mr. Seward**, a vote of thanks was passed to the chairman, directors, and officers of the Company.

NATIONAL ELECTRIC SUPPLY COMPANY, LIMITED.

The annual meeting of shareholders of this Company was held at 119A, Fishergate, Preston, on Wednesday. There were present Mr. E. H. Booth, J.P. (chairman), Mr. H. Curwen, Mr. J. Booth, and Mr. W. Brown (directors), and a fair number of shareholders.

The **Chairman**, in moving the adoption of the report and accounts, said in 1893 their total income was £3,345, and their total expenditure £4,354, showing a loss of £1 009 for the year; in 1894 their total income was £4,778, and the total expenditure £3,783, showing a profit of £995, and a reduction of expenses £571. Their income last year was £5,739, and expenditure £3,338, showing a profit of £2,401, and a reduction of expenses over 1893 of no less a sum than £1,016. The Corporation were beginning to appreciate the light, and had decided to light most of the public thoroughfares and streets, and also had in contemplation the lighting of all their public buildings. The churches also were taking it.

Mr. E. Pyke seconded the motion, which was carried unanimously.

Mr. J. Booth was re-elected a director, and the auditors were also appointed.

BRITISH ELECTRIC TRACTION (PIONEER) COMPANY, LIMITED.

The general meeting of this Company was held last week at Winchester House, E.C., Sir Charles Rivers Wilson presiding.

The **Chairman** stated that no resolution had to be submitted. The capital of the Company was £100,000, and 5 000 shares were offered to the public, who responded so readily that the amount asked for was subscribed many times over. The directors had been actively employed in pursuing the objects of the Company. They were at present promoting a Bill in Parliament for constructing electric tramways from Kidderminster to Stourport, a distance of 3½ miles. This would involve an expenditure of about £30,000 or £40,000. They were also promoting a provisional order for the construction of electric tramways from Oldham to Ashton and Hyde a very important route passing through a thickly-populated district in the neighbourhood of Manchester. They had several other important negotiations connected with a variety of localities, but for various reasons it would be undesirable to allude to them further on that occasion. With regard to the question of the system of electric traction which was likely to be introduced and to become the system of the future, they believed they had acquired the right to a system which partook of the nature of the open-conduit system, and which would be unattended by any of the inconveniences to which he had referred. It would also be extremely economical. They were greatly indebted to their colleague, Mr. Garcke (the managing director).

CENTRAL LONDON RAILWAY COMPANY.

The first report of the directors states that £506,420 has been received on account of shares, and that the amount expended was £168,285, leaving a balance in hand of £338 135. The engineers have been engaged in negotiations with the local authorities respecting the details of the stations and other works. and the contractors—the Electric Traction Company, Limited—have proceeded, as far as possible, with the acquisition of the necessary land for the station sites. and a commencement will shortly be made wi h the actual construction of the railway. An arrangement has been come to with the Waterloo and City Railway Company, whereby, in consideration of a contribution by them to the cost of construction, and afterwards of maintenance, they will have access by a subway from their City terminus to the system of public subways to be constructed by the Central London Company in connection with their central City station. This arrangement will facilitate the exchange of passengers between the two companies The Board of Trade has given the necessary certificate relative to the payment of interest during the construction of the line The passing of a formal resolution at an extraordinary general meeting to follow the ordinary meeting sanctioning the issue of the capital authorised by the Act of 1892 will not involve any increase in the amount of the capital offered for subscription in June last. From the accounts it appears that the mileage authorised is 6 miles 34 chains, no part of which is yet constructed Of the expenditure stated above, £115,000 was under the construction contract, directors' fees absorbed £1,800 and interest on the paid up capital at 3 per cent. £7,300.

The first half yearly meeting of the Company was held on Thursday at the Cannon street Hotel, under the presidency of Mr. Henry Tennant.

The **Chairman**, in moving the adoption of the report said he had no doubt that they would remember their line commenced at the Liverpool street Station and ended at Shepherd's Bush, running by the Bank and under Oxford street to its destination. It was to be constructed by means of two separate tunnels from end to end, and when completed they would be adequately lighted. There were to be 14 stations. The shareholders would also remember this other interesting fact—that the railway was to be worked by means of electricity. A contract was entered into with the Electric Traction Company and by this contract that company were to deliver over the railway and all its adjuncts in a complete state. The accounts presented showed that £506,420 had been received on account of the shares issued, and there had been spent £168,265. The principal item of expenditure, £115,026, was entered under the head of payments on account of the contractors. The unissued shares had been subscribed for under agreement by the Electric Traction Company, who had become liable for them to this Company. The unissued shares he referred to amounted to £682,470 of the total share capital of £2,850,000. The further expenditure on capital account was roughly estimated at £3 380,000 and this, added to the expenditure already incurred, brought the figure up to about £3 550,000. The authorised capital powers amounted to nearly £3,800,000, so they had a margin of about £200,000 left for contingencies. although he did not think any were likely to arise. As regarded the Mansion House station and subways—a work of great magnitude and intricate character—the plans had been approved by the City authorities, and the contractors would before long make a commencement at that point. He might also say that tenders had been invited by the Electric Traction Company for the construction of the tunnel for nearly the whole of the line. Those who undertook to execute these works would have to begin their operations on the sites of properties which would be taken down and afterwards replaced by stations. Another meeting of shareholders would be held in about six months' time, and they would then probably be informed from the chair that during those six months the work of construction had been set going very nearly from one end of the line to the other. At one time it was thought that there might be some difficulty in arranging with the Great Eastern Railway Company for establishing communication between Liverpool street Station and the station of the Central London Railway at that point, but he believed all difficulties had been removed. The Waterloo and City Railway, whose terminus was at the end of Queen Victoria street, had also entered into an arrangement for using the subways at the Mansion House which this Company had to construct. The engineers stated that their more detailed studies had only confirmed their opinion that no physical difficulties would be encountered in the construction of the line.

Lord Colville seconded the motion.

The **Chairman**, in reply to Mr. Griffith, said none of the directors of the Central London were directors of the Electric Traction Company, nor had they any financial interest whatever in that company.

The resolution was then agreed to.

At the special meeting which followed, the **Chairman** moved: "That the Board be authorised to raise £150,000 additional ordinary capital by the issue of 15,000 new shares of £10 each in pursuance of 55 and 56 Vict., cap. 241."

The **Hon. Mr. Mills** seconded the motion, which was adopted unanimously.

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CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

Directors: J. Irving Courtenay (chairman); Major-General Webber, C.B., retired R E (deputy-chairman); Nugent Danioll; Emile Garcke; G. N. Marten. Managing engineer: Frank King. Secretary: S J. Cluer.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the annual ordinary general meeting of the Company to be held at the Central Station, 19, Cadogan-gardens, Chelsea, S.W., on Wednesday, May 4, at 12 noon:

During the year an issue has been made of £60 000 4½ per cent. debenture stock, which was fully subscribed. The balance of the ordinary shares authorised has also been allotted and fully paid up. The original 6 per cent. debentures (£36,900) have been redeemed. A Stock Exchange quotation has been granted for both the debenture stock and ordinary shares. The balance of the premiums on these issues, after deducting the expenses of issue (including the payment of the premium due on the redemption of the 6 per cent. debentures), amounts to £5,798. 8s. This balance has been dealt with in the net revenue account as under: amount placed to renewals and depreciation fund, £1,500; special law and incidental expenses written off, £3,251. 1s. 5d: amount placed to reserve fund, £1,047. 6s. 7d. The above item, £3,251. 1s. 5d, is special capital expenditure, and has been necessitated by legal proceedings in connection with the Cadogan-gardens generating station. The directors have decided to write off this amount out of the premiums, instead of spreading it over a number of years in a capital suspense account. The net revenue for the year (apart from the premiums) after payment of debenture interest (£3,143 16s. 3d.), is £6.414 16s. 5d. Of this, £900 has been paid as interim dividend at the rate of 6 per cent. per annum on the preference shares for the half-year to June 30, 1895, and the directors recommend that the balance of £5,514. 16s. 5d. shall be applied as under: dividend of 6 per cent. per annum on the preference shares for the half-year to December 31, 1895, £900; dividend of 5 per cent. per annum on the ordinary shares for the year 1895, £3,500; balance to be carried forward to next account, £1,114. 16s 5d. The price charged for current was reduced on July 1 from 8d. to 6d. per Board of Trade unit, a reduction of 25 per cent. The number of lamps supplied on December 31 1895, was 57,354, showing an addition of 10 068 during 1895, an increase of upwards of 50 per cent. on the number added in 1894. A considerable part of the capital expenditure has been incurred in extending the mains and enlarging the Cheyne-walk generating station in order to meet the increasing demand for current. An advantageous purchase has also been made of the freehold of a large plot of land around and including Cheyne-walk station in view of the necessity for providing increased accommodation for the Company's works. The retiring directors are Mr. Nugent Daniell and Mr. E. Garcke, who, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also offer themselves for re-election.

REVENUE ACCOUNT YEAR ENDING DEC. 31.

Dr.	£ s. d.	£ s. d.
To Generation of Electricity.		
Coal or other fuel, including expenses on the same	2,230 12 3	
Oil, water, cotton waste, and engine-room stores	443 13 10	
Wages of men	1,170 16 9	
Repairs, maintenance, and renewals as under: buildings, £53. 11s. 4d.: engines and boilers, £401. 6s. 4d.; dynamos, £4. 13s. 8d.; instruments, tools, and sundries, £71. 6s. 1d.	530 17 5	
		4,376 0 3
To Distribution of Electricity.		
Wages at out-stations, meter winding and reading	357 5 8	
Stores used at out-stations	28 7 7	
Repairs, maintenance, and renewals as under: mains, £43. 3s. 11d.; accumulators and apparatus at distributing station and motor transformers, £114. 19s. 4d.; meters on consumers' premises, £26. 12s. 5d.	184 15 8	
		570 8 11
To Rent, Rates, and Taxes.		
Rents payable	699 5 0	
Rates and taxes	304 12 8	
		1,003 17 8
To Management Expenses.		
Directors' remuneration (part of £1,000—balance waived)	843 0 0	
Salaries of staff	930 15 0	
Salary or commission of collector	98 2 6	
Stationery and printing	89 19 1	
General establishment charges	129 19 8	
Auditors of Company	35 0 0	
		2,126 16 3
Law expenses	13 13 1	
		13 13 1
To Special Charges.		
Insurance	117 14 3	
Wayleaves	6 0 0	
Canvassing	60 15 0	
		184 9 3
Balance being gross profit		8,889 11 2
		£17 164 16 7

Cr.	£ s. d.
Sale of current (less allowances made)	16,006 5 9
Rental of meters	642 4 1
Transfer fees	30 5 0
Rents receivable, discounts, and sundry small accounts	486 1 9
	£17,164 16 7

GENERAL BALANCE-SHEET, DEC. 31, 1895.

Dr.	£ s. d.
Capital account—amount received	160 500 0 0
Bills payable	1,741 12 7
Sundry creditors	8,058 0 7
Reserve fund	1,047 6 7
Balance at credit of net revenue account, £6,414. 16s. 5d.; less interim dividend paid on preference shares, £900	5 514 16 5
	£176 861 16 2

Cr.	£ s. d.
Capital account—amount expended, £160,881. 9s. 8d.; less renewals and depreciation fund account, £4 000	156,881 9 8
Stores on hand—coal, £88. 17s. 6d.; general stores, including work in progress, £1,286. 14s. 3d.	1,375 11 9
Sundry debtors for current supplied, etc.	6,168 11 0
Cash at the London and South-Western Bank, £2 393 16s. 7d.; cash on deposit, £10,000; cash in hand, £42. 7s. 2d.	12 436 3 9
	£176,861 16 2

SCARBOROUGH ELECTRIC SUPPLY COMPANY, LIMITED.

The directors report that during the past year the Company continued to make satisfactory progress. There is a balance of £937. 9s. 8½d., which is more than twice the profit made in 1894. Adding the balance of £418. 12s 3d. carried forward from the previous year, there is £1,356 1s. 11½d. available for distribution. The directors recommend that this should be applied in paying a dividend of 2½ per cent., leaving a balance of £278. 12s. 11d. to be carried forward. Mr. J. E. Ellis, M.P., and Mr. Gilbert Wilkinson, the retiring directors, together with Mr. C. E Bradley, the auditor, offer themselves for re-election.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

The directors' report states that the accounts for the year show a net profit of £32,589. 14s. 1d., after charging the interest on the debentures. To this sum must be added £53,509. 18s. 5d. brought forward for last year, making a total of £86,099. 12s. 6d. From this amount is deducted the interim dividend of 5 per cent., paid July 23, 1895, amounting to £22,410, leaving £63,689. 12s. 6d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1. 4s. per share, absorbing £44,820, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1. 16s. per share, or 15 per cent, free of income tax, leaving £18,869. 12s. 6d. to be carried forward to the next account. Various lengths of telegraph cables have been manufactured for different cable companies, and for foreign and Colonial Governments, including 705 knots for the Government of Japan. It is added that repairs of the Greetseil-Valentia and Hoyer-Arendal cables have been successfully carried out for the German Government.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER COMPANY, LIMITED.

Directors: Alexander Bruce, J.P. (chairman), Ballaquayle Villa, Douglas; Frederick George Callow, advocate, Ballacurrie, Onchan, Douglas; John Allen Mylrea, M.H.K., J.P., Derby-terrace, Douglas; Alfred Jones Lusty, Goldhurst-mansions, London; William Parke J. Pittar, The Cliffe, Douglas; Richard Farrell, LL.D., Hazelmere, Douglas. Manager: J. Aldworth. Secretary: W. E Young.

Report of directors and statement of accounts for the year ending December 31, 1895:

Including the sum brought forward from last year, the available profit, after providing for debenture interest, amounts to £13,240. 1s. 6d. Out of this sum, interim dividends on the preference and ordinary shares for the first six months of the year, at the rate of 6 per cent. and 7½ per cent. per annum respectively, amounting to £4,312. 10s., have already been paid; and the directors now recommend that a further dividend for the remainder of the year, at the rate of 6 per cent. per annum on the preference shares and 8½ per cent. per annum on the ordinary shares, amounting to £4,687. 10s., be declared payable on March 6, 1896; that the sum of £2,000 be added to the reserve and renewal fund, and that the balance of £2 240. 1s. 6d be carried to profit and loss new account for current year. The directors have to report that the traffic upon the electric line has been very satisfactory; so much so that, in addition to the four new motor cars and one saloon car constructed and used during last season, the directors contemplate ordering more cars to cope with the enormous and growing traffic. The permanent way has been extended to the centre of Laxey during the past year, and arrangements have been made for a

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much more convenient station. Several waiting-rooms have also been erected at convenient places along the route The directors have arranged for the purchase of a portion of the Derby Castle grounds, at the junction of the electric and horse car lines together with two houses adjoining, upon which it is proposed to erect a suitable station, depôt, and offices, and so concentrate the working of the different lines. This will enable the directors to dispose of other valuable property not so conveniently situated. The directors have also to report that during the past year, after considerable negotiations, arrangements have been made, and agreements entered into, with the Douglas Town Commissioners, by which this Company has secured a further 21 years' lease (from 1897) of the Douglas Bay line, also power to double the entire line and to construct and work a cable tramline to Upper Douglas, which has now been commenced. These agreements have been confirmed by Act of Tynwald, full particulars of which have already been sent to the shareholders. The work of construction has been entrusted to the eminent firm of Messrs. Dick, Kerr, and Co. Limited. Preliminary arrangements have also been made for the purchase of the Snaefell Mountain Railway, which, it is considered, will prove highly advantageous to the Company, and the approval and sanction of the shareholders thereto will be asked at the extraordinary meeting. It is proposed to raise the cash required for the construction of the Upper Town tramway and the purchase of the Snaefell Mountain Railway by the issue of debenture stock The shareholders will further be asked to pass resolutions altering certain parts of the articles of association of the Company, which the directors are advised would be desirable in the interests of the Company, the particulars of which have been already forwarded to the shareholders. The whole of the plant, rolling-stock, permanent way, buildings, etc, have been added to and maintained in an efficient manner during the year. The retiring directors this year are W. P. J. Pittar and Richard Farrell, LL.D., both of whom are eligible and offer themselves for re-election. The auditors, Messrs. Aldred, Astbury, Turner, and Co., also retire, and offer themselves for re-election.

Dr. BALANCE-SHEET.	£	s.	d.
Share capital—50,000 preference shares of £1 each	50,000	0	0
75,000 ordinary shares of £1 each	75,000	0	0
Debentures (first mortgage)	50,000	0	0
Mortgage (since paid off)	1,100	0	0
Total capital raised	176,100	0	0
Sundry creditors (including material for Upper Town tramway)	12,759	3	4
Debenture interest accrued	1,250	0	0
	190,109	3	4
Reserve and renewal fund	2,000	0	0
Profit and loss account, £13,240. 1s. 6d.; less interim dividend, paid October 1, 1895, £4,312. 10s.	8,927	11	6
	£201,036	14	10

Cr.	£	s.	d.
Capital expenditure as per last account	170,919	8	2
Since expended on permanent-way extensions, buildings, stations, rolling-stock, Upper Town tramway, etc.	17,543	11	8
	188,462	19	10
Investments	480	0	0
Stock and stores on hand	1,352	0	10
Horses in stock	1,696	10	0
Sundry debtors	658	11	3
Cash at bankers and in hand	8,386	12	11
	£201,036	14	10

Dr. REVENUE ACCOUNT.	£	s.	d.
General expenditure, including forage, fuel, traffic, stores, rents, rates, licenses, advertising, repairs and renewals, horsing, wages, payment to Commissioners, etc	11,989	14	1
Balance (carried to profit and loss account)	14,467	1	10
	£26,466	15	11

Cr.	£	s.	d.
Total gross income	26,466	15	11

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Debenture interest, £2,500; interest on mortgage, £49. 12s. 9d.	2,549	12	9
Balance	13,240	1	6
	£15,789	14	3

Cr.	£	s.	d.
Balance from last year	1,672	12	5
Less directors' fees	350	0	0
	1,322	12	5
Profit as per revenue account	14,467	1	10
	£15,789	14	3

Telegraph Construction and Maintenance Company.—The transfer books of this Company will be closed till the 3rd prox., preparatory to payment of dividend.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Naples—Tenders are wanted by March 9 for 3,500 kilogrammes of copper wire The estimate is 6,475 lire. Address, La Fonderia reale, Napoli.

Lima (Peru).—Tenders for the electric lighting of the city of Lima will be received up to June 1 next at the Peruvian Legation, Avenue Hache 8, Paris.

Droylsden.—Tenders are required for the supply of dynamo, accumulators and all necessary for 20-light installation. Box 12, Post Office, Droylsden.

Namur.—Tenders will be received on July 10 next for the construction of a telephone building at Namur. Plans and particulars can be obtained from le Service Téléphonique, Namur.

Leeds.—Firms desiring to tender for the various works required in extension of the electric light station in Leeds, should send their names to Messrs. Milnes and France, architects, 99, Swan-arcade, Bradford.

Brunn (Austria).—The Municipality desire offers for the construction and working of a central station for the supply of electric energy for lighting the town, for power, and, if required, for running a tramway Tenders must be sent before March 31 to the Bürgermeister, Brünn, Austria, from whom particulars can be obtained.

Lisbon.—Tenders are wanted by the Royal Portuguese Railway Company for the supply of apparatus for electric alarm bells. Tenders, suitably endorsed, must be sent to the Chief Engineer, at the Company's Stores, Santa Apolonia, Lisbon, by March 11, and particulars, etc., can be obtained from the Paris Offices of the Company, at 28, Rue de Châteaudun.

Christiania.—Tenders are wanted for the supply of telegraphic instruments, including 26 Morse apparatus, 11 galvanometers, and three signal bells, paper tape, etc., for the Norwegian State Railways. Tenders must be sent in by March 11 to the office, Iernbanctorvet 8 9, and particulars can be obtained of the Inspector of Telegraphs, Ostbalnistation, Christiania.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grange-town, Yorkshire, to whom the plans, etc., must be sent by May 1.

London, S.W.—The Guardians of Chelsea invite tenders for the supply and fixing of telephones and communications with certain wards and rooms of their infirmary in Cale street, in accordance with a specification which may be obtained, and samples of the instruments and fittings which may be seen, at their offices, 250, King's-road, Chelsea. Tenders must be delivered at the Guardians' offices by noon on March 10.

Paris.—The Direction générale des postes et des télégraphes, rue de Grenelle 103, Paris, require tenders for the supply of 10-millimetre and 16-millimetre paper tape for telegraphic instruments. Application for permission to tender must be made to the Direction by March 14, and tenders sent in by March 24. Tenders are also wanted for nine lots of apparatus for telegraphic offices. In this case application must be made by March 15, and tenders sent by March 25.

Herne (Germany).—It is proposed to make a street railway nine kilometres (5½ miles) long from Herne to Recklinghausen, to be worked either by gas motors or electric traction. The undertaking will be put out to general competition, and the contractor will have to covenant for its completion in from one to five years. Tenders must be sent in by March 18, and particulars, price 1 mark (1s.), can be obtained from Herr Amtmann Schaefer, Der Verwaltungsausschuss Herne.

Keighley.—Tenders are invited for providing and fixing telephonic communication between the various buildings forming the infectious hospital now in course of erection at Morton Banks, near Keighley, for the Keighley and Bingley Joint Hospital Board. The buildings and plans can be inspected on application to Mr. Alfred Moore, clerk of the works at the hospital. Tenders, marked on the outside "Tender for Hospital Telephones," will be received by Mr. Geo. E. Spencer, clerk, North-street, Keighley, not later than noon on March 4.

Hanover.—Tenders are wanted for the supply to the State Railways during the ensuing year of certain articles for the telegraphic service of the districts of Altona, Cassel, Erfurt, Hanover, and Münster. The contract includes 250 lamp globes, 40,000 lamp chimneys 38,600 zincs and 22 500 coppers for galvanic batteries, 40,900 kilogrammes sulphate of copper, 5,040 kilogrammes sulphate of zinc, 159,700 rolls of paper-tape, etc. Conditions and particulars can be obtained from the Rechnungsbureau, Königliche Eisenbahn Direktion, Joachimstrasse, Hannover.

Chesterton (Cambs).—The Urban District Council is open to receive tenders for the public lighting of the district for seven years. The tenders shall be made in the three following modes—namely, (*a*) lighting the district from August 14 to May 15 (inclusive) in each year; (*b*) lighting the district throughout the whole year commencing May 15 next; (*c*) lighting the district for either of the above periods (1) with ordinary burners, (2) with incandescent burners, if the illuminant with which the tender be made be gas. All cleaning, lighting, and maintenance to be done by the contractors. Tenders to be sent to Mr. James Spearing, clerk, 15, Sydney-street, Cambridge, by March 31.

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Sunderland.—The Corporation want tenders for the following plant required at the electric supply station: (*a*) two steam-engines and continuous-current dynamos, with steam and exhaust pipes and switchboard extensions; (*b*) two water-tube boilers of Babcock and Wilcox type; (*c*) fuel economiser; (*d*) a water-softening plant; (*e*) a cast iron tank. Specifications, general conditions, and form of tender can be had at the office of the borough electrical engineer, electric supply station, Sunderland, on payment of a deposit of £1. 1s for each of the above. The deposit will be refunded on the receipt of a bona fide tender. The tenders will be let subject to the consent of the Local Government Board to the application of the borough of Sunderland for the extended loan for the above works. Tenders to be delivered at the office of Mr. Fras M. Bowey, town clerk, Town Hall, Sunderland, by 5 p.m. on March 13, addressed to the Chairman of the Highways Committee, and endorsed "Tender for Extension of Electric Supply Station."

Bangor.—The Corporation invite tenders for the construction, supply, and laying down of the necessary plant and mains for the supply of electricity in the borough. The contract will be split up into two sections: (1) construction, supply, and erection of boilers (water-tube), steam-engines (double acting), steam and exhaust pipes, etc., economiser, feed pumps, condenser, alternators, exciters, accumulators, switchboard, travelling crane; (2) supply and laying down of mains and transformers. Specifications and plans may be obtained on payment of £2 2s. for the former and £1. 1s. for the latter, which will not be returned, at the office of Mr. F. Hastings Medhurst, M.I.E E., Westminster-chambers, 13, Victoria-street, S.W., on and after 24th inst. The firm whose tender is accepted will be required to enter into a contract and a bond with two approved sureties for the due performance of the contract. Firms may tender for one or both sections, but tenders for a part only of either section will not receive consideration. Sealed tenders, endorsed "Electricity," to be delivered at the office of Mr. W. H. Pritchard, town clerk, Bangor, by March 18.

BUSINESS NOTES.

Deal.—The present gas-lighting arrangements are causing much dissatisfaction, and correspondence in the local Press shows a decided leaning towards the adoption of electric light.

Harrow.—The work of laying the electric light mains by the Harrow Electric Light and Power Company is in hand and the erection of the electric light station in West-street is progressing.

Shoreditch.—The Vestry have decided to borrow £31,381 for the purpose of electric lighting works. These include a dust destructor, chimney shaft, ironwork for dust destructor, and electricity supply.

Brixton.—Mr. John Fyfe, the founder of the Electric-avenue, has been entertained at a complimentary banquet at Holborn Restaurant. The chair was taken by the Hon. Evelyn Hubbard, M P. for the division.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending February 23 amounted to £1,059, as compared with £847 in the corresponding week of the previous year, being an increase of £212

Appointment Open.—The appointment is open of professor of mechanics and mathematics at the Royal College of Science. Candidates should communicate with the Secretary, Science and Art Department South Kensington, S.W.

Bolton.—The borough surveyor (Mr. W. H Brockbank) and the electrical engineer (Mr. J. H. Rider, M I.E E.) have visited Dublin in order to inspect the Southern District Tramways Company's system, which has just been completed between Dublin and Dalkey.

Northern Society of Electrical Engineers.—The adjourned discussion on Mr. Robert Hammond's paper on the "Parallelling of Alternators," read by him before the society on 10th inst. at Manchester, will now take place on Monday, March 9, instead of Monday, March 2.

Moss Side (Lancs.).—At the Urban District Council meeting, the clerk read a communication from Messrs. Collier-Marr in which they stated that the Board of Trade had informed them that unless the electric lighting order previously granted was proceeded with, the Board would revoke it.

Cardiff.—The members of the Property and Markets Committee have inspected the new lighting of the central market by electricity, and decided to make certain recommendations to the Council, including further light inside the shops and also the electric lighting of the Old-arcade.

W. T. Henley's Telegraph Works.—The directors of W. T. Henley's Telegraph Works Company, Limited, propose subject to audit, paying a dividend of 5 per cent upon the ordinary shares for the year ending December 31, making, with the 3 per cent. already paid, a total of 8 per cent. for the year.

Newcastle-on-Tyne.—The proposal of the Corporation to acquire the tramways has been rejected by the ratepayers by a small majority. The Bill will therefore be dropped, and the question of the mode of traction to be adopted drops also. A very large proportion of the voting papers were returned blank.

Huddersfield.—Amongst the applications which have been made to the Board of Trade with a view to being embodied in provisional order Bills for consideration during the present session of Parliament is the Huddersfield electric lighting order, to authorise the Corporation to supply electricity in the town and to spend £24,000

Acton.—At the meeting of the District Council the Works Committee recommended that Mr. Goddard's application with reference to lighting Mr. Cohen's estate by electricity be refused. The clerk having suggested for consideration some legal points, it was resolved, after a brief discussion, to defer a decision till the next meeting.

Burton.—At a special meeting of the Town Council held for the purpose of passing formal resolutions dealing with the erection and issue of new 3 per cent stock, the Mayor (Councillor Morris) said the electric light was costing between £1 700 and £1,800 a year, but it was in its infancy, and year by year the deficit should become smaller.

City and South London Railway.—The returns for the week ended February 23 were £968, compared with £949 for the corresponding period of last year, being an increase of £19. The total receipts for the half year terminating as above were £7,914, compared with £7,988 in the same period of the preceding year, being a decrease of £74

Brighton.—A complete installation of the electric light has been carried out at the Turkish baths by Messrs. Clifford Hawkes and Walton, of East-street. In the House of Commons on Tuesday, the Brighton and Rottingdean Seashore Electric Tramroad Bill was introduced by the borough members, Mr. Gerald Loder and Mr. Bruce Wentworth.

Cuckfield (Sussex).—At a meeting of the Board of Guardians the clerk submitted specification for providing and fixing telephonic communication in the workhouse, etc., and it was resolved that the tender of the Private Wire and Telephone Company be accepted subject to their undertaking to keep the works in good working order for six months.

Macclesfield.—The Health Committee have received a letter from Mr. Radford which recommended that the electric light should be introduced on the farm buildings at Butley, at a cost of about £170 He had estimated for a supply of lamps, but thought the electric light would be the best in the long run. The subject was left over for consideration at the next meeting.

Torquay.—The Town Council have decided to apply for leave to borrow £22,300 for lighting the borough with electricity. A private meeting of opponents of the electric lighting scheme has been held for the purpose of considering what steps shall be taken to prevent the expenditure of ratepayers' money in the matter. It was decided to call a public meeting on the subject.

Eccles.—A special meeting of the Town Council has been held for the purpose of considering the advisability of appointing a deputation to the Board of Trade and Local Government Board for the purpose of applying for an extension of time in regard to the electric lighting order. It was decided to wait till the enquiry into the application to borrow £20,000 had been held.

Electric Light Insurance and Maintenance Company, Limited. This Company has been registered, with a capital of £10,000 in £1 shares, for the purpose of entering into contracts and issuing policies of insurance for the maintenance in proper order of all electrical appliances, and to carry out contracts for electric lighting. The registered office is 120, Bishopsgate street, E.C.

Eston.—At the meeting of the Urban District Council the surveyor reported that, in reply to the advertisement which he had been instructed to have inserted, he had received offers from several electrical engineering firms to submit schemes for lighting the district with electricity. They asked for plans of the district, which he was busy preparing. The schemes had to be in by May 1.

Bath.—The representatives of the Urban Sanitary Authority and the electric light company have met at the offices of the Board of Trade and discussed the proposed purchase by the authority of the company's undertaking with Sir Courtenay Boyle and Major Cardew. It is stated that there was such a wide divergence between the views of the respective deputations that no provisional agreement was come to.

Safety Concentric Wiring Company.—This Company inform us that they have acquired the business hitherto carried on under the style of J. D. F. Andrews and Co., at 15, Marsham street, and temporarily at 34, Victoria-street, the Company having bought outright the whole of the goodwill, all the patents, stock-in-trade, fixtures, etc, and that Mr. J. D. F. Andrews has now no longer any connection of any kind with the firm or patents.

Limerick.—Water power is proposed to be used for electric light and power production and supply to the city of Limerick, the Shannon, of course, furnishing the energy. The actual force available on an average throughout the year, in the 15 miles from Killaloe to Limerick, according to careful calculations made by the late Sir R. Kane, amounts to nearly 34,000 h.p. Winter time, with its greater need for artificial light, brings a corresponding increase in the volume of the Shannon's flow.

Bermondsey.—At a meeting of the Vestry Mr. Ball moved: "That a special committee of 18 members be appointed to consider and report upon the advisability of applying to the Board of Trade for a provisional order authorising the Vestry to supply electricity for public and private purposes within the parish, and as to the advisability of erecting a dust destructor in conjunction with the above works" Mr. Wells seconded and the motion was adopted, but the appointment of the committee was deferred.

King's Norton.—The House Committee having recommended the Guardians to make arrangements to light the new workhouse with the electric light, Mr. J. Botteley moved an amendment to

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the effect that before taking any further steps in the matter the committee should consider and report upon the advisability of purchasing machinery and boilers powerful enough to light both the infirmary and the workhouse from the same plant. Mr. T. A. Bayliss seconded the amendment, which was carried.

Huddersfield.—At the meeting of the County Council the minutes of the Electric Lighting Committee, which were confirmed, set forth that the financial statement of the electric supply department for the year ending December 31 last showed a balance due to the revenue account of £1,373 4s. A resolution was accordingly passed requesting the Finance Committee to make provision for this deficit in their next rate. The sum of £2,500 had been ordered to be taken up on loan from the borough fund for capital expenditure.

Portsmouth.—The Electric Lighting Committee have decided to ask the Town Council to appoint a special committee, consisting of the chairman, vice-chairman, and five members of the Electric Lighting Committee, and a like number of the Roads and Works Committee, to consider the question of taking over the lines of the tramway company. It is suggested that the Corporation may, with profit to the town, adapt the lines for running cars by electricity, the tramway company paying rent to the Corporation for the use of the lines.

Inferior Lamps.—The Westminster Electric Supply Corporation, Limited, have called the attention of consumers "to the inferior quality of certain lamps, many of which are made in Germany. These give a brilliant light at first, but quickly deteriorate, causing complaints, which are entirely unfounded, that the pressure at which the Corporation is supplying is insufficient. The best makers have their names engraved on the glass, and by buying only lamps thus marked it is easy to avoid untrustworthy brands."

Belfast.—The Lord Mayor, accompanied by several members of the Municipality and the municipal engineer, have already visited Havre to examine the working of the electric tramways. They were received at the town hall by M. L. Brindean, deputy and mayor of Havre, with his principal officers, and M. Pupeteray, manager of the electric tramway company, who subsequently conducted the party over the works where the electricity is generated and the car depôts, and over the various tracks. The party also visited the docks, and subsequently left for Paris.

Kingston (Surrey).—The Electric Lighting Committee have reported that they had confirmed the acceptance by the chairman (Councillor Collings) of the offer of the Royal Exchange Insurance Company for the insurance of the electric works for £8,000, at a premium of 5s. per cent. Letters had been received stating that at present there was no probability of the barracks, the railway station, or the police station being lighted with electricity The Town Council decided to carry out the work of providing apparatus for charging electric launches at a cost of £150 10s

Edinburgh.—Augustine Church, George IV. Bridge has been wired for electric lighting, and the halls will be fitted up next week. The installation has been carried out by Messrs. Lowdon Bros., of Dundee. The Cleaning and Lighting Committee of the Town Council have considered a motion in favour of lighting by electricity all the remaining public thoroughfares in the city as defined by the tramway routes, and a motion as to the lighting by electricity of the West Port. On a division the committee resolved to recommend that no action should be taken in the matters referred to.

Dover.—The amount stated in the estimates of the Town Council for electric lighting is £950. At the quarterly meeting of the Finance Committee a conversation took place as to the charges for the use of the electric light in the town hall. The ordinary supply, it was stated was inclusive with the letting charge of the hall; but when the full lights were all on, there was an extra charge of 5s. per hour. The bills for ordinary and extra lighting were examined, and Mr. Councillor Brown, who initiated the discussion, said the charge appeared to be very satisfactory.

Holophane, Limited.—This Company has been registered by Messrs. Dixon, Watts, and Elkin, Savoy Mansions, Savoy, W.C., with a capital of £100 000 divided into 100,000 shares of £1 each, with the object of adopting an agreement made between O A. Mygatt and the Company for the acquisition of certain patents, patent rights, etc, relating to the construction of holophane glass globes, and the benefit in any country, except the United States of America and France, of all improvements in the patents, and to carry on business as manufactures and dealers in holophane glass globes and other globes.

Company Bills.—The report by the Board of Trade upon all the railway, canal, tramway gas, electric lighting, and water Bills and provisional orders deposited for the present session states that the total number of Bills deposited relating to railways, canals tramways, and the supply of gas, electricity and water is 157, as compared with 129 deposited for last session. The total amount of money proposed to be raised under these Bills is £41,009 183 as compared with £23,236,850, being an increase of £17.772 333 By the 53 Bills relating to gas electric lighting, and water undertakings, power is sought to raise £8 542,150, or more than £5,038 450 as compared with 1895.

London Extensions.—Notice having been given under the Electric Lighting Acts and orders by the Vestry of intention to lay mains across Camden-road and along a part of Kentish Town-road, the Highways Committee of the London County Council recommended that sanction should be given under certain conditions. Similar sanction was recommended to notices from the Metropolitan Electric Supply Company of intention to lay mains in various streets in the Edgware-road district; from the House-to-House Electric Light Supply Company to lay mains on the south side of Kensington-road, Oxford-street; and from the London Electric Supply Corporation to lay distributing mains in Park-street and Northop-street, Oxford street.

Dundee.—At a meeting of the Gas Committee of the Town Council it was stated that the patent for Dr. Hopkinson's three-wire system of electric lighting, which is in use in the city, expires in July next, having lasted 14 years. Dr. Hopkinson has sold his patent to the Westinghouse Company, and they have intimated their intention of applying for a 14 years' extension of the patent. A communication was read from the Glasgow Town Council asking the Dundee Council to join with them and other towns in opposing the granting of the application, the cost to be allocated in accordance with the quantity of wire used in the different towns. The Gas Committee agreed to recommend the Council to accede to the request of the Glasgow Town Council, and oppose the extension of the patent.

Bradford.—In reference to the question of electric propulsion on tramways, it will be remembered that the Corporation permitted an experiment which was rejected, in the overhead wire system on the portion of the line from Forster-square up Cheapside and into Manningham-lane. The advocates of electric traction maintain that the system was rejected without full and fair consideration Firstly, on the æsthetic side, they say that the overhead wires, when put up permanently, are not uglier or more of a nuisance than lamp-posts or telegraph poles; and, secondly, on the question of cost, they say that one element left out of sight is the great saving—50 per cent.—in wear and tear of the rails, which under steam traction has been found by the Corporation to be so important an element in the ultimate balance of profit and loss.

Sevenoaks.—At the meeting of the Urban Council, the Electric Lighting Committee reported that they had considered the letter from the secretary of the gas company, and they recommended that a contract be entered into with the company for a further period of three years from March 25 next. Councillor Hickmott suggested that the contract with the gas company should be for two years and not for three, seeing that there was a great probability of the electric light being introduced into the town. If the electric light be obtained at as cheap a rate as the gas, he, for one, should certainly adopt the former. The clerk did not think there was any need to alter the contract from three to two years, seeing that the electric light promoters had not yet got their provisional order, and some time must elapse before such an order could now be obtained. The report was adopted.

Worcester.—A report having been read at the meeting of the Library Committee in which reference was made to the frequent breakage of electric lamps in the classrooms of the institute, the Chairman stated that these accidents were due to the cheap make of the lamps. Mr. Millington said that he thought that the committee were quite satisfied that the cause of the breakage was the cheap quality of the lamps, and not, as had been suggested, the variation in the current. He suggested that that committee should authorise the sub-committee to provide better lamps for one room, and if those went the same way as the others, they would be prepared to do anything else in reason to remedy the defect. He, therefore, moved that the order for £17 worth of the old lamps be rescinded, and that Brush lamps be ordered for trial in one room. Mr. Joseland seconded, and the motion was carried.

Felixstowe.—At a meeting of the Urban Council, the clerk Mr. F. B. Jennings) read a letter from the gas company, stating that they could not light Ranelagh-road and other new thoroughfares as there were no mains within reasonable distance. Mr. Downing remarked that as the authority had expensive machinery at work the time had perhaps come when the Council should take some opinion as to the lighting of the place with electricity. They were paying £300 or £400 a year for lighting the streets, and yet the gas company did not seem inclined to go out of their way to light up certain roads because there were no mains sufficiently near. Mr. Hill considered the inhabitants had reason for complaint at there being two charges, one of 3s. to 3s. 6d. to those who used gas-engines, etc, and another of 5s. to private consumers. The question was referred to a committee for consideration.

Swansea.—The Corporation have been compelled by the action of the tramways company to withdraw the Bill before Parliament which would have enabled the town to have electric cars, electric light and a refuse destructor. The suggestion that an arrangement should be arrived at with the Mumbles Railway Company for the running of the latter's trains by electricity supplied from the Corporation generating station is now being considered by Sir John Jones Jenkins and his co-directors. The question for discussion is whether the expenditure necessary for the erection of an electricity station will now be justified. It is stated that Mr. J. C. Howells, of Llanelly, has written to the Corporation offering to purchase its provisional order. In order to protect the town against a monopoly, he is willing to enter into an agreement by which the Corporation can acquire the plant at intervals of seven years for net cost and a goodwill represented by the clear profits.

Central London Railway.—At the London Sheriffs' Court, Bloomsbury, before Mr. Under Sheriff Burchell and a special jury, the case of Ryalls' Trustees *v.* the Central London Railway Company has been heard. It was a claim by Messrs. Leonard Atkinson Ryalls, solicitor, Sheffield, and Hugh Hutton Stannus, 61, Larkhall-rise, Clapham, as trustees for Mr. Charles Wager Ryalls, 59, Haverstock-hill, barrister-at-law, the beneficial owner, against the Central London Railway, for the sum of £6,216, as

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compensation for premises situated at 31, Holborn, required by the Company for the construction of a railway station. Mr. Littler, Q C, and Mr. Coward appeared for the claimants and Mr. G. M Freeman, Q.C. and Mr. E. Boile for the respondents. Mr James Green, surveyor to the Board of Trade and her Majesty's Board of Works, Major Isaacs, and Sir J. Whittaker Ellis gave evidence in support of the plaintiffs' claim, while witnesses called on behalf of the respondents put the value at £4,400, or at 25 years' purchase. Ultimately the jury found for a sum of £5,430.

Leeds.—The visit which the Highways Committee of the Corporation intended to pay to Bristol over a week ago, but which was unavoidably postponed, has now been completed. Most of the members of the committee—including the chairman (Mr. T. Hannam) the city engineer (Mr. T. Hewson), the manager of the tramways (Mr. W. Wharam), and the highway surveyor (Mr. T. A. Prince)—were present. After an inspection of the whole of the electric section, which is established on the overhead system, the committee proceeded to the power station, which is situate about midway on the route. The equipment of the station and of the whole line impressed them as being a complete mechanical success. The town clerk of Leeds (Mr. Harrison) has received a telegram from the parliamentary agents to the Corporation stating that it had been decided to dispense with the usual standing orders of the House of Commons in regard to the Leeds Tramways Bill. Accordingly the Bill will now proceed. The measure seeks to obtain power for the Corporation to provide for the working of the city tramways by electrical traction.

Hull.—A public meeting convened by the Mayor (Alderman Richardson) has been held for the purpose of considering the desirability of establishing electric communication with lightships and lighthouses. It was called in response to a requisition signed by 235 persons, but at the hour for commencing the proceedings at noon not more than half-a-dozen people were present. The Mayor explained that the requisition contained the names of such gentlemen as Mr. C H. Wilson, M.P., Mr. C. E. Lake (North-Eastern Railway Company), Alderman Toozes, and other representative gentlemen, and he felt it his duty to convene the meeting, but as there was so small an attendance he did not think they would be justified in calling it a "town's meeting" and he had no option but to adjourn it *sine die*. The meeting was consequently adjourned. At a meeting of the Electric Lighting Committee the chairman said that they had a good many orders coming in, and by the end of the present year they would have overtaken all the capabilities of their present station. A proposal to extend the system was referred to sub committee. With regard to the proposed reduction in the charges for electric lighting, the engineer said he would not recommend any reduction to consumers at present.

Hammersmith.—The following report from the Electric Lighting Committee in regard to the proposed electric light works was read at the Vestry meeting: "That having further considered the Clause 2 of our last report referred back to us by the Vestry at the last meeting we now recommend that when the surplus soil, for the excavation and removal of which the Vestry accepted Mr. Greenham's tender, has been removed the Vestry do proceed to excavate the sand and ballast, this work to be done by piecework. The sand so excavated to be used for the Vestry's general purposes, and the ballast retained for the concrete foundations" The recommendation was agreed to. The committee further reported: "That so soon as a definite plan and scheme has been approved and adopted by the Vestry, we recommend the Vestry to proceed, with its own workmen, to put in the whole of the concrete foundations for the plant and buildings, under the supervision of the surveyor, and at an estimated cost of 12s. per cubic yard, or £425." Mr. Bendon moved that this clause of the report be referred back to the committee, on the ground that the Vestry ought not to pledge itself to spend 12s. a yard upon the work when it could be done by piecework at 9s. per yard. Mr. Johnson seconded, and a long discussion upon the subject took place. Upon being put to the vote, the amendment was lost and the recommendation of the committee was then agreed to.

Dublin.—Mr. Wm. Anderson, secretary to the Dublin United Tramways Company, has written to the Lord Mayor pointing out that the decision of the committee in fixing a rent for which the assent of the Corporation would be given to the application of the Southern Tramways Company, who had made no offer, while ignoring his company's definite proposal, was come to without affording his company any opportunity of reconsidering their proposals. The directors had in consequence decided to make several proposals. They offered to pay the Corporation an annual rent of £8,000 per annum when authority to equip and work with electrical power the whole of the city tramways had been obtained, such mileage rent to commence to accrue for each line or section of tramways when the necessary authority for electric traction on such line is obtained. They undertook not to increase their present scale of fares and to construct necessary extensions, and they also undertook to convey the cars and traffic of the Southern Tramways Company into the centre of the city whenever they were permitted to erect an electric installation from Haddington-road, on terms to be settled by arbitration. The letter was read at the meeting of the Corporation, and deputations from the United Tramways Company, the Southern District Tramways Company, and the Dublin electric opposition also attended and addressed the meeting. The following resolution was unanimously adopted: "That the several letters from the Dublin United Tramways Company be referred to a committee of the whole house, and that the company be requested to make an offer as to the rental as well as the terms upon which they will extend the purchase provision of the Act of 1870 to all the existing lines over the system after the expiration of 14 years, and that the committee be authorised to confer with the company at its meeting if necessary."

The Tramways Union.—At the annual general meeting of thie Company on Tuesday, the Chairman (Mr. J. E. Walker), in moving the adoption of the report, said that in two out of the three cities which they supplied with means of conveyance, the future of the Company and their profits depended upon the introduction of electric traction. Not only did the present profits depend thereupon, but they had every reasonable hope that those profits would be very largely increased by the introduction of electric traction. By means of electric traction they could carry more people in one car, or two cars, the one being attached to the other. They could travel at an increased speed, and at those periods of the day when their largest requirements of traffic pressed upon them, they could carry large numbers of persons to and from particular points. It was impossible to do that with horses without keeping a very large and disproportionate staff, but with any mechanical power they could at a particular period of the 24 hours increase the application of that power, and thereby move a larger number of carriages and naturally carry an increased number of people At Bremen the matter was now under the consideration of the Senate or Town Council. With regard to Madrid, matters were very much in the same position, although they had not reached quite such an advanced stage; but in Spain, as elsewhere, the desire of the public seemed to be that electric traction should be introduced. The motion was unanimously passed.

Bristol.—At the half-yearly meeting of the Bristol Tramways and Carriage Company, Limited, the Chairman referred to the application being made by the company for an extension of the electric traction system, and expressed a hope that the Corporation would not persevere in their present course of imposing conditions which the company could not reasonably be expected to acquiesce in. Alderman Low seconded the motion, which was supported by Mr. Geo. White (managing director) and others, and carried unanimously. At the meeting of the Town Council the Town Clerk said a memorial had been received from the St. Paul's branch of the Labour Electoral Association suggesting that in any new powers granted to the tramways company the city should insist upon the employés of the company having an eight hours' day, that working-men's tickets should be issued for a double journey at a single fare, and that the necessary electric current should be supplied by the city. Alderman Cope-Proctor, in moving the adoption of the Electrical Committee's report with reference to the Bristol Tramways Order of 1896, said the tramways company had sought to obtain general powers to adopt the overhead electrical system but the committee thought it would be better that, whenever an extension was agreed upon, that particular extension should be brought before the Council. Another paragraph dealt with the specific extension now contemplated—from West-street to the Lebeck Inn, Stapleton-road, with an arrangement that next year the system in this direction should be extended to Fishponds The committee had gained from the company the concession for fares for workpeople between Old Market-street and Kingswood not to exceed 1d. Regarding the supply of electricity, the Corporation Electrical Committee were desirous that the power for propelling the cars be obtained from them; but for the moment they were willing to forego that condition in regard to the Stapleton-road section, and would consent to its being supplied from the company's own station. Councillor Hughes seconded the resolution, and it was carried. Councillor Pearson moved, "That the Sanitary Committee and the Electrical Committee be appointed a committee to consider and report upon the question of the introduction of the overhead trolley system of electric traction in the city, and if such a system should be sanctioned, then to report upon the terms upon which such sanction should be given." Mr. Alderman Proctor Baker seconded the motion, because he desired to see an immediate extension of the tramways to Fishponds. He was in favour of the extension of the electrical system to the whole of Bristol. The motion was carried.

North Staffordshire Tramways Company.—At the ordinary general meeting of this Company on Tuesday the chairman (Mr. W. J. Carruthers Wain) moved, "That the directors be requested to proceed with the pending negotiations with the various local authorities for the adoption of electricity as a motive power instead of steam and that the agreement between the British Electric Traction Pioneer Company and the Company dated January 8, 1896, be approved, and that the directors be and hereby are requested to carry the same into effect." He said the circumstances which had arisen in regard to the North Staffordshire Tramways were these: When under the usual statutory authority the Board of Trade inspector early last year inspected their lines with a view to a renewal of the permission to use steam power upon them, he found that a considerable amount of renewal of lines was necessary. He also discovered that there was a strong desire on the part of the inhabitants and on the part of the local authorities to replace the mode of force with which their line was at present worked by some other more attractive and more modern method. The Company had a limit of time given to them within which to renew the bulk of their line The desires of the inhabitants and of the local authorities went beyond the mere use of steam, and although they naturally desired the substitution of some better mode of traction it was left to the directors to propose a mode of traction. Consequently the question of electric traction, which had come so much to the front in England of late years had been considered. A company well known on account not only of the position it occupied but on account of the gentlemen connected with it, was

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willing to enter into an agreement with them whereby they would find the amount of money necessary to relay the remainder of their line and to equip it from end to end electrically, which meant the expenditure of a very considerable amount of money—the provision of all the necessary generating plant and the supplementary station, the erection of posts and wires in the road, the bonding of the rails so as to ensure proper electrical continuity, and everything else inseparable from an electrically-worked line He was confident that from the moment the shareholders gave their approval the position of the ordinary shareholders would be very much improved and their security increased. Mr. Alderman E. J. Hammersley, in seconding the motion, said by adopting electricity they would get a more frequent service of cars and a cleaner and more effective form of traction, and in that way they would ensure the support of the public and the co-operation of the numerous local authorities in the district. The motion was carried unanimously.

Cork.—The electric tramway company have forwarded to the Board of Guardians a copy of a notice of application to be made to the Grand Jury for the sanction of a tramway scheme for the city and suburbs. As it was proposed to cross over one of the Guardians' sewers on the Victoria-road, they desired the consent of the Board. The matter has been referred to Mr. Coakley, engineer. At a meeting of the Public Works Committee a long report was read from the acting city engineer on the proposed scheme for providing electric tramways, in which, after describing the routes to be followed and the manner in which certain objections should be overcome, he said: "The promoters do not give any particulars in their notice as to the mode in which tramcars will be worked, whether by overhead or underground wires. When the former scheme was considered it was decided on your engineer's report, that a system of overhead wires should be adopted, carried at a sufficient height on ornamental cast or wrought iron posts or pillars. It was proposed to fix these posts about 20ft. apart at either side of the narrow streets and in the centre of the wide streets, and that the maximum potential of current through the head wires should be 500 volts. One great objection to these overhead wires is that in many places they are placed at such a low level as to prevent the passage of a fire-escape through the streets. Another objection is that the posts in some instances would obstruct the footways, and have an unsightly appearance. If these objections are got over, and if your committee should see their way to sanction the scheme, I see no objection to their doing so, provided the following conditions are agreed on: (*a*) the maximum potential of the current should be limited to 500 volts; (*b*) the wires should under no circumstances be fixed at a lesser height from the road way than 24ft; (*c*) the poles should be ornamental in structure, and of a design to be approved by your city engineer, and made of cast or wrought iron; (*d*) wall backets should be used in Cook-street instead of posts, provided the promoters obtain the consent of the owners of houses upon which the brackets may be fixed; (*e*) the position of the posts or poles should be subject to the approval of the city engineer; (*f*) the promoters should undertake to permit the Corporation in case they should at any future time undertake the lighting of the city by electricity. or any company who should undertake the public lighting by agreement with the Corporation, to use for that purpose any poles or brackets which may be erected by the tramway company; (*g*) that in case the company should go into liquidation the Corporation should become the owners of the permanent way. including setts and rails, and that same should not be disturbed or removed at any time without the express consent of the Corporation in writing. The promoters seek for power to construct the tramways to a gauge of 3ft., or such other gauge as the order may direct. In my opinion the 3ft. gauge is the most suitable, and wider should not be permitted. The notice accompanying the plans gives no particulars whatever of the size or section of rails to be used, and is most vague in its terms. Full particulars should be supplied before any formal assent is given to the scheme." The Chairman suggested that the report should be printed and circulated. Mr. Firmo asked if the promoters required a guarantee from the Corporation. The Secretary (Mr Giltinan) said they did not. It was only proposed that the order should enable the Corporation, if they could see their way to do so, to contribute towards the scheme, and enter into agreements with them as to the maintenance of the streets. Mr. M. O'Donnell said they should be very glad to get the ground for nothing. Mr. Firmo proposed that they approve of the engineer's report. The proposition was agreed to. It was also decided to leave the further consideration of the question over until the matter comes before the Council.

Wimbledon.—At a meeting of the District Council a memorial, signed by 160 North Wimbledon residents, was read in opposition to the electric lighting scheme. A deputation, headed by Dr. Wyld, also waited upon the Council and spoke in support of the statements contained in the memorial. The Chairman (Mr. A Holland), in reply, said the Council had given a great deal of attention to the electric lighting and incandescent gas lighting; they had consulted well-known authorities, and they thought they knew something about the merits of both systems of lighting. As regarded the incandescent gas light, there was no mystery about its brilliant illuminating powers. They saw it in the streets, and one of their reasons for not encouraging the gas company to make their so-called experiments was because they did not want them, knowing what the light was. It was in numerous buildings, and some in the open air, but they did not feel that it was for the benefit of the community to bolster up a monopoly of gas, and he hoped to show that Dr. Wyld was quite wrong in saying that incandescent gas was six times as cheap as the electric light. They did not consider it necessary to make a special appeal to the ratepayers when they were representatives of the ratepayers, and when, as was well known in all such cases of appeal, vested interests appeared They had seen that the gas company was working very hard against them although he did not insinuate that any gentlemen who had signed the memorial were interested in the gas company. If they increased the number of consumers they had to increase the cost, but he had a communication from a competent authority who was willing to carry out the whole of their scheme for £32 000. It had been proved over and over again that electricity at 6d. per unit was equal to gas at 3s. per thousand. Therefore electricity cost the same as gas, and not twice as much. The cost of incandescent gas, based on the present price of gas—3s. 8d. per thousand—was £3. 3s. 4d. per annum for each lamp, and that of a 32-c p. electric light, which an expert told him was equal to a 50-c.p. incandescent light, was £3. 11s. 4d. Mr. Bennett-Williams said it was the general opinion that the opposition to the electric light emanated from the Incandescent Gas Company, but there was not the slightest suspicion of that in connection with the deputation. They had only had one expert's opinion in favour of incandescent light as against electric light, and he would like to know if it was true that the cost of his coming to Wimbledon was defrayed by the incandescent light people. Dr. Wyld: Yes. Colonel Ross remarked that at Guildford the incandescent gas-lighting had been found very successful. At Kingston the cost of installing the electric light in private houses was £1 per light. The Chairman said the cost of installation depended on the fittings. It could easily be done for less than £1 per light in the case of simple suspension lamps. After a little further discussion the deputation withdrew. At a later stage the Chairman reported that Mr. Whitfield and himself recently attended at the Local Government Board offices and interviewed the head official there. They showed him the letter they had received from the Board of Trade with reference to the extension of their electric light license for a couple of years, and he stated that if the Council would write to him, enclosing a copy of the communication from the Board of Trade, he thought he could see his way to authorise the Council to take up a loan for the extended period next October the Council giving an undertaking to apply for a provisional order in the meantime On the granting of the provisional order the loan would be granted for 25 years on the usual terms Mr. Donaldson said he should be sorry to appear a "wobbler," but his opinion as to the advisability of introducing the electric light into Wimbledon had been a little shaken by the deputation. He would move that the Council give the gas company an opportunity of making their suggested experiments. Mr. Crickmay seconded. The motion only received the support of the mover and seconder, and was lost. The Chairman then moved that the steps suggested by the Local Government Board official he had referred to be taken by the Council. Mr Casswell seconded. and the motion was adopted with only two dissentients—Messrs. Crickmay and Donaldson.

Glasgow.—At a meeting of the Electric Lighting Sub-Committee reports were submitted by Mr. Foulis (gas manager) and Mr. Arnott (the electric engineer) bearing upon the position of matters as at present existing, and making suggestions with the view of improvement. The committee agreed to co operate with the Watching and Lighting Committee so far as street-lighting is concerned; but the whole system will be fully discussed by the joint committee on an early date, with a view to the adoption of the best method of lighting the whole municipality by electricity. The Tramway Committee of the Corporation have taken a further step in regard to motive power for the tramways. They have appointed Mr. Young (the manager), along with a member of the committee, to visit cities on the Continent where electric tramways are at work, and they have empowered the deputation to make a report embodying such information as might prove valuable when the Corporation as a body comes to discuss the adoption of some new motive power for working the tramways in the city The minutes of the Committee on Electric Lighting, which were considered at the meeting of the Corporation contained a recommendation that the Waterloo-street station should be extended and provided with additional plant at a cost of £6 000. The minutes of the special sub-committee contained the following report by Messrs. W. Foulis and W. Arnot: "We have carefully considered the saving that might be effected by transferring the arc lighting from John-street to Waterloo street, and supplying the lamps from the low-tension mains at present used for private lighting. This transference would necessitate new lamps being procured, as the present lamps are unsuitable for continuous low-tension current. The cost of the lamps, with the necessary connections, they estimated at £1,300. From the higher efficiency of the plant at Waterloo-street, as compared with that at John-street, and also from the fact that the additional current may be generated without extra cost for labour. the saving to be effected they estimated as follows: reduction in cost of fuel, £257; reduction of wages, £431; making a total of £688. Additional capital would be required for plant at Waterloo-street. but the sum that would probably be realised from the sale of the building and plant at John-street would meet this expense. The sum above mentioned was equal to £6 10s 4d. per lamp, reducing the cost per lamp per annum to £22. 10s. 1d" The special sub-committee approved the report, and resolved to recommend that the supply of current required for the existing street arc lamps be transferred from John-street station to the station in Waterloo-street. The special sub-committee also resolved to recommend that, in addition to the remit to them referred to in the minute of 20th ult., it be remitted to them to consider and submit an exhaustive report as to the supply of electricity for

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private and public lighting, or for motive power, within the entire municipal area, with power to the special sub-committee to take such action as they may deem expedient to enable them to submit such a report. Mr. R. M. Mitchell moved the approval of the minutes. Bailie Burt, in seconding the motion said that when the electric light was introduced in Glasgow it was started on an experimental basis, and the committee had gone as far as they were warranted. So far as the private lighting was concerned they put down 1,200 h.p. at the station. The first winter they added another 700 h.p., the second winter another 700 h.p., and they now proposed to add another 700 h.p. They had thus practically completed the scheme as originally sketched. So far as the station was concerned, they could go no further, and despite the fact that the Post Office, one of their best customers, had put in an installation of their own, he maintained that so far as the private supply was concerned the demand had gone up by leaps and bounds. As to the street-lighting, unfortunately at the time it was inaugurated electricians were not so well up in the matter as they were to-day, but so far as Glasgow was concerned he held they had not made a very great mistake In 1893-4 with a capital of £120,000, they had a deficit of £607. Last year the deficit was a little more, but that was accounted for by the constant changes, and that they were not in a position to get customers to take up the supply. Over and above that, he believed they would come out this year with a very fair surplus. After a lengthy discussion, the motion was carried by 27 votes to 13 With a view to enable them to arrive at a satisfactory rearrangement of the lighting of the principal thoroughfares of the city by electricity, the Joint Lighting Committee of Glasgow Corporation have resolved to discard a number of the present lamps at the west end of Sauciehall-street and substitute in their places, as an experiment, opaque circular globes, similar to those in use in Edinburgh. The ventilation of the "Kief," the new steamer just built by Messrs. J. and G. Thomson at Clydebank, is by means of electrically-driven fans.

PROVISIONAL PATENTS, 1896.

FEBRUARY 17.

3535. The automatic electric self-registering long-distance signalling apparatus. William Rowland Hugh Inglis, Frodingham, near Doncaster.

3550. Improvements in simultaneous telephony and telegraphy. Edward Wythe Smith and the New Phonopore Telephone Company, Limited, Faraday House, Charing Cross road, London.

3556. Improvements in telephone paper racks. John Francis Bullock, 64, High-street, Camden Town, London.

FEBRUARY 18.

3627. Improvements in telephones. William Henry Russell, George Ellsworth Russell, Francis Millard Neale, and Henry Connett, Prince's-chambers, Wolverhampton. (Complete specification.)

3628. A new or improved dynamo brush. Francis Edward Elmore, Knostrop Old Hall, Leeds.

3633. Improvements in and connected with electric alarms and indicators. Frederick George Thomas and John Thornton, 70, Market street, Manchester.

3658. Improvements in joints for the conduits of electric mains. George Schultz, 70, Palace-chambers, Westminster.

3682. An improvement in multiple-contact circular electric switches. Siemens Bros. and Co., Limited, and Zachary Harris Kingdon, 28, Southampton buildings, Chancery-lane, London. (Complete specification)

3690. Electromagnetic induction system of propulsion. Alpheus Carpenter Shuttleworth, 46, Lincoln's inn-fields, London. (Complete specification.)

3705. Improvements in dynamo-electric machines. Valerè Alfred Fynn, 47, Lincoln's inn-fields, London.

3712. Improvements in electric accumulators. F Mouterde Camille Chavant, and J. George 18, Buckingham-street, Strand, London.

FEBRUARY 19

3736. Improvements in electrical accumulators. Thomas Parke , Wednesfield-road, Wolverhampton.

3761. Eight-day and above electric alarm clocks. George Houlsby Skee, Coundon, Bishop Auckland.

3796. Improvements in electrically-driven machinery for cutting coal or other minerals. Claude William Atkinson, 1, Queen Victoria-street, London.

3809. Improvements in sockets and holders for incandescent electric lamps. John Francis Cleverton Snell, Arthur Henry Martin Francis, and Robert Spilsbury Jeffery Spilsbury, 70, Chancery-lane, London.

FEBRUARY 20.

3823. Improvements in electrical lamps. Louis Pohlmann Foster, Penny Bank-chambers, Halifax.

3841. Improvements in and in connection with arc lamps. Frank Michael Lewis, 30, Park-row, Leeds.

3842. Improvements in cranes, specially applicable to electrically-driven cranes. Henry Berry, 30, Park-row, Leeds. (Complete specification.)

3846. Improvements in electrical generators. Thomas Harden and Samuel Glover, Corporation Gas and Electricity Works, St. Helens.

3847. Apparatus for reversing the flow of electrical currents. Thomas Harden and Samuel Glover, Corporation Gas and Electricity Works, St. Helens.

3864. Electrical thermometers. Charles Dexter Barker, 30, Agate-road, Hammersmith London.

3908. Improvements in electrical dial-indicating and communicating apparatus. Arthur Edward Butcher, 53, Chancery-lane, London.

3910. An improved magnetic regulator for the carbons of arc lamps. Frederic Klostermann, 97, Newgate street, London

FEBRUARY 22.

4028. An improvement in the construction of ammeters and voltmeters. Thomas James Baker, 65, New-street, Erdington, Warwickshire.

4033. Improvements in diffusing and colouring the light from incandescent electric lamps. J A. Sinclair, 55, Rowan-road, Hammersmith London.

4069. An electric vaporiser for oil-engines. Ernest John Clubbe and Alfred William Southey, 53, Chancery-lane, London.

4082. Improvements in or connected with apparatus for electrically igniting miners' safety lamps. William Ackroyd and William Best, 33 Chancery-lane, London.

SPECIFICATIONS PUBLISHED

1895.

2064. Electric switches. Hopkinson.

2218. Counters for electric currents. Hummel.

3055. Electric steering apparatus. King.

4154. Electro-deposition. Cowper-Coles Galvanising Syndicate, Limited, and Cowper-Coles.

6177. Alternating-current dynamos. Esson

6545. Arc lamps. Davenport.

6657. Incandescence electric lampholders. Lyons and Bevis.

7458. Electrolysis for metallic salts. Kellner. (Second edition.)

13670. Electric incandescent lamps. Cooper.

24516. Voltaic batteries. Epstein.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1-1¼
—— Non. Cum., 6 per cent. Pref.	2	1⅛-1¼
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	6⅜-7½
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6⅜-7½
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	130-132
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10-11
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-2⅝
Edison and Swan United Ordinary	3	1½-2
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1½-1⅝
—— 7 per cent. Cumulative Pref.	2	2½-2⅝
Elmore's Copper Depositing	2	⅛-¼
Elmore's Wire Company	2	¾-1
Fowler-Waring Cables	5	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	15-16
—— 7 per cent. Preference	10	16½-17½
—— 4½ per cent. Debentures	100	109-112
House-to-House Company, Ordinary	5	3⅜-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge Ordinary	5	7½-8
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅞-8⅛
Liverpool Overhead Railway	10	13⅜-13⅞
—— 5 per cent. Pref.	10	15½-16
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅜-½
Metropolitan Electric Supply	10	12-12½
—— 4½ per cent. First Mortgage Debenture Stock	100	115-118
National Telephone, Ordinary	5	6½-7
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16-17
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6½
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	8½-9
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8⅝
—— £4½ shares	4½	6⅜-7½
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	9⅜-10½
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	33-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	5⅜-5⅝
Westminster Electric Supply, Ordinary	5	9½-10
Yorkshire House-to-House	5	6⅜-7½

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NOTES.

Obituary.—The death, at the age of 91, of Mr. S. Edison, the father of Mr. T. A. Edison, is reported from Norwalk, Ohio.

Northern Society of Electrical Engineers.—We hope to give Mr. Robert Hammond's paper on "The Paralleling of Alternators" in our next issue.

Submarine Boat.—As accessory to a competition for a submarine torpedo boat, the French Ministry of War have offered prizes for designs of a motor suitable for such a vessel.

University College, Bristol.—Mr. B. H. Bedall has been lecturing to the University College Engineering Society on electric tramways. The lecture included some remarks on the subject of electric locomotives. A discussion followed.

Engineers in Parliament.—The members of the House of Commons who are also engineers—or at any rate, eight of them—have held a meeting and decided to co-operate for parliamentary purposes. So far as numbers go, it does not seem a very formidable group at present.

Institution of Civil Engineers.—Mr. W. H. Wheeler's paper on littoral drift in relation to river outfalls was read at the Institution of Civil Engineers on Tuesday last. Mr. Wheeler's point was that wind action was confined to a comparatively small depth and was variable, while the action of the tidal current was continuous, and was therefore the main factor to be considered.

New York Overhead Railroad.—It is stated that the officials of the Manhattan Elevated Railway have, after considerable investigation, concluded that a combined system of third rail and storage battery is best adapted to meet the requirements of their road; they have, therefore, decided to equip the Thirty-fourth-street branch on that principle. Should it prove a success, the application to the rest of their lines will follow.

Trees and Lightning.—Dr. Cl. Hess, of Frauenfeld, contributes to the *Elektrotechnische Zeitschrift* an article on "The Poplar Tree as a Lightning Conductor," and gives statistics showing how often various trees are struck. Unless one wants to choose a tree to stand under during a thunderstorm the matter seems of little practical utility, but the different liabilities of various trees to be struck by lightning are well known to countrymen.

Leeds Engineers.—A paper has been read by Mr. J. Clark Jefferson before the Leeds Association of Engineers on the subject of tram haulage. After discussing the local circumstances of the place, he came to the conclusion that the overhead electrical system was most suitable to many of the routes, but contended that it was not necessary to have one uniform system throughout, and was not inclined to abandon the cable on the Chapeltown route. A discussion followed.

Acetylene.—It is known that acetylene is an endothermic gas, and therefore the possibility of it exploding when detonated is a matter that requires determination. So far as the experiments communicated to the Paris Académie des Sciences at Paris by Mr. Maquenne go, it would seem that such an explosion, if it were brought about, would not travel in a tube. Mr. Maquenne's experiments were made with fulminate detonators, and mixed gases were used.

Theatrograph.—Mr. R. W. Paul's moving-picture apparatus was shown last Friday evening at the Royal Institution, and its manageable size and comparative simplicity was favourably remarked on. As a non-technical contemporary puts it, "the whole thing can be comfortably packed in an ordinary portmanteau, and is worked by hand much like a chaff-cutter." It is hoped to have something of the same sort, but on a much larger scale, ready for the forthcoming Earl's Court Exhibition.

Exhibitions.—Information has been received by the Foreign Office respecting the international exhibition to be held in Brussels in 1897. There are 14 sections, of which No. 7 is devoted to electricity, and special attention is to be given to traction. The Canadian International Exposition opens on May 25. Russia has already accepted the invitation of the French Government to take part in the Paris Exhibition of 1900, and is the first of the great European Powers to do so.

A Dangerous Lark.—This is the heading under which the *Daily Chronicle* considers it appropriate to record the fact that last Sunday someone left three cells of a galvanic battery on a doorstep in Leamington. This was undoubtedly a particularly stupid thing to do, but where the danger came in, whom the cells were to hurt, and how, is not stated. The police took expert advice and consulted an electrician, who said the cells "were alive with electricity." Probably that electrician was also a humorist.

Spain.—The *Revista Tecnológico Industrial* of Barcelona says that electric lighting is now being established in Burriana (Castellón). This is a continuous-current installation, driven by a 100 h.p. steam-engine. A similar station is being built at Estepa (Seville). It is proposed to erect a turbine of 280 h.p. at Los Fayos in Tarragona for electric lighting purposes; and the illumination of Palma by electric light seems likely to be speedily accomplished. This has already been done at Darunes, and a further extension is reported from Hervás.

City and Guilds Institute.—The Executive Committee of the City and Guilds of London Institute have awarded the second Salters' Company's Research Fellowship for the encouragement of higher research in chemistry in its relation to manufactures to Mr. Sidney Williamson, Ph.D., F.I.C., F.C.S., who was for two years a student at the City and Guilds Technical College, Finsbury, an subsequently for three years at the City and Guilds Centra Technical College. Dr. Williamson proposes to work on some questions bearing on foodstuffs generally.

Lightning.—The *Pacific Electrician* says that either California is experiencing a very unusual winter or the climate is changing. It seems that quite a number of electric plants in that State have been badly damaged by lightning during the past winter. Attention has naturally been directed to lightning arresters. Our contemporary says that a few years ago no one thought of providing against lightning on the Pacific Coast except in a few special localities. Probably these thunderstorms are the Californian equivalent of our English mild winter.

The Rede Lecturer.—Prof. J. J. Thomson, M.A., F.R.S., who has been elected this year's Rede lecturer, is 40 years of age, but his life has been already academically and scientifically an eminent one. In 1880 he graduated at Cambridge as second wrangler, was Smith's prizeman, and was Adams's prizeman in 1883. Since 1884 he has been professor of experimental physics at Cambridge. He is the author of a treatise "On the Motion of Vortex Rings" and on "The Application of Dynamics to Physics and Chemistry," and has done good work in connection with electrical units.

Electric Cranes.—On the occasion of the recent visit of the North-East Coast Institution of Engineers and

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Shipbuilders to Wallsend a good deal of interest was taken in the electric cranes at Messrs. Swan and Hunter's yard. There are three of these—two under the roof of the yard and one on the outside. The two under the roof weigh 14 tons each, and run along at the rate of 200ft. per minute with a weight on their jibs of three tons each. The cantilever crane outside the roof weighs six tons and has a jib of 65ft. projection, reaching right across the adjacent berths. The entire structure is made of steel.

Institution of Electrical Engineers.—It has been arranged, by permission of Messrs. Siemens Bros. and Co., that a party of students shall visit their works at Charlton on Saturday, March 14. The train leaves Charing Cross Station at 10.20 a.m., Cannon-street 10.30, and London Bridge 10.33, and passengers should book to Charlton Junction. Students desirous of being of the party must write to the honorary secretary of the students' class, Mr. G. C. Allingham, Eldon House, Lyndhurst-road, Hampstead, N.W., as soon as possible, and those who do not hear from him to the contrary may assume that they can be included in the party.

Electric Ploughs.—Some time ago we noted the attempts being made in Germany to work out a system of electric transmission of power for steam ploughing purposes. During the winter further experiments have been made at Rostock, in which an alternating current of 2,000 volts from a central station was used and transmitted to the field 2¼ miles distant, where it was transformed down to 220 volts. Two electric motors were used. As much as 25 h.p. seems to have been required, but no details are obtainable. Unless there happens to be cheap water power available, this does not seem likely to compete with a good portable engine in the field.

The Higher Voltage.—Mr. Stewart has given, in the *Western Electrician*, his experience as to the installation of over 15 central stations in the North-West of the United States with 200-volt lamps, and says that most engineers there are now specifying that system exclusively. Careful experiments covering many months show that the danger from fire is less, as the danger is not from voltage but from current. The small fuses of the 220-volt system give way at the slightest approach of danger, and sockets spark less. With good workmanship such a system is safer than any other, and bad workmanship is going out of favour. It is furthermore stated that the life of most of the lamps is 1,500 hours or over. After this it need hardly be added that Mr. Stewart believes the 220-volt lamp has come to stay.

University College of South Wales.—A circular, signed by the principal, president, and registrar, deals with the objects and work of the Cardiff University College, in view of the endeavour which is now being made to raise funds for new college buildings. In reply to an application from the college authorities, the Lords Commissioners of the Treasury promised a grant of £20,000 towards the new buildings, provided a like amount is contributed from private sources; and the Drapers' Company of London have agreed to make a donation of £10,000 towards the same object, if the above-mentioned £20,000, to be collected locally to meet the Treasury grant, is contributed before the end of July next. Of this sum as much as £13,464 has been already promised, Lord Tredegar and Lord Windsor heading the subscription list with £2,500 apiece.

Nomenclature Again.—No more has been heard of the euphonious word electrosciography, but inventors desirous of immortalising themselves seem to find it much easier work to invent new names for the Röntgen ray pictures than to explain the nature of the process. Captain Abney's favourite is electrography. Our contemporary *Photography* wants the word to be Röntography. Our objection is that if Prof. Röntgen's name is to come into the word, it might as well be spelt properly. Another proposal is radiography. None of these seem particularly happy suggestions. Some, however, of the American electrical papers have taken to calling the prints "cathodograms." That is just the one thing that they are not. With the aid of a Greek lexicon it would be possible to go much better than any of these—if it were worth while. Other gems are "shadowgram" and "penetraliography."

A Paris Electric Tramway.—With the exception of a few tramcars run with accumulators, little has been done in the way of electric traction in Paris up to the present. The reason of this is that the city authorities have absolutely refused to permit the adoption of overhead-wire systems. A line, however, is now in course of construction on the underground system of Messrs. Claret and Vuilleumier, and is briefly described in *Cosmos*. This is a closed-conduit system, the current being taken from metal plates between the rails, which are brought into circuit as the car passes over them. A similar line has been tried successfully at Lyons. The Paris line is to run from the Place de la République to Romainville, a distance of seven kilometres (4¼ miles), of which more than half are within the city. A portion of the line is already laid, but the station for generating the current is not yet finished. A tension of 500 volts is to be used, and it is expected that the service will be a seven-minute one, the whole journey taking half-an-hour.

Municipal Telephones Association.—In reference to the recent town's meeting in Manchester which decided adversely to the proposition that the Manchester Corporation should establish a telephone exchange, a circular has been issued by the Municipal Telephones Association to the subscribers of the requisition for the meeting. The circular states that "the executive committee of this association have in their possession absolute proof that the meeting was packed by persons brought from towns outside Manchester who were not ratepayers in the city," and adds that "the committee are, of course, in no way influenced by a vote obtained in such an unscrupulous manner. They are now preparing a scheme which will shortly be submitted to the City Council for its approval; and inasmuch as no risk of loss to the ratepayers is involved, there is strong reason for believing that it will be approved." An appeal is further made for the support of telephone users. There has been a large amount of correspondence on the subject in the local Press.

Post Office Telegraphs.—A parliamentary return has been issued showing the gross amount received and the gross amount expended in respect of the telegraph service from the date of the transfer of the telegraphs to the State to March 31, 1895. The total receipts between 1870 and 1895 were £43,137,892. 7s. 6d., and the total expenditure (including £2,636,982. 2s. 3¼d., balance to meet interest on stock created on account of the telegraph service and the redemption of debt) was £43,967,675. 15s. 8¾d., leaving the balance of receipts over expenditure at £829,783. 8s. 2¾d. Another return for last year states the total receipts for 1895 at £2,646,413, and the expenditure at £2,788,051, a loss of £141,637 being thus shown. Whether this means that the Post Office ought to make no more extensions, or whether, on the other hand, extra facilities should not be given and everything done to attract more custom, or whether simply that, considering everything, including the invention of the telephone, the companies were exceedingly lucky in getting bought out by the Government, is a

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matter that would take more space to deal with than can be given in this note.

Electricity and Vegetation.—Mr. G. Claude, writing in *L'Etincelle Electrique* on the influence of electric discharges on vegetation, gives a summary of what has been done by several investigators in this direction. In particular, he relates an old experiment of Mr. Spechnew, in which a network of wire furnished with arrangements to facilitate discharge was stretched over a field and kept at a high potential relative to the earth. The result was an increased growth, varying from 132 to 2 per cent. with the eight different kinds of crop experimented on. It is suggested that the explanation of the phenomenon is to be found in the formation of nitrates from the air under the influence of the discharge. The figures given, however, do not in any way support this view, since the increased growth is greatest on the part of clover, which it is now known can manufacture its own nitrates, and least on the part of wheat, which cannot, but which responds vigorously to an artificial supply of them.

Undue Heating.—The *Electrical Age* has obtained quite an anthology of opinions as to what is the meaning of "unduly heated" in the definition of the safe carrying capacity of a conductor. Prof. Crocker considers any heat which is bearable to the hand as perfectly harmless. In dynamos and motors the allowable rise is 40deg. to 45deg. C., as measured by a thermometer placed against the surface and covered with cloth; in wiring, the most usual standard of a safe current is the number of amperes which, if doubled, will not raise the temperature above 150deg. F. Mr. Edison thinks that the conductors should not heat more than 212deg. F. Mr. Wiener, after a certain amount of calculation, arrives at a final temperature of 140deg. F. Mr. Loomis defines "undue heating" as heating to a temperature which impairs the insulation. This is obviously wide of the mark. Mr. Dunn says for wire enclosed in mouldings it would mean, according to Edison regulations, a rise of more than 18deg. F.; for dynamos it means a rise greater than 81deg. F. Prof. Elihu Thomson will not define the term in degrees, but it is safe to say that when a wire is quite hot to the hand ordinary insulating materials are on the point of injury. The only safe rule is to use such a wire as will under a great variety of circumstances still remain within safe limits of temperature, and, fortunately, the use of such a size of wire is conducive to the best economy.

Electric Light in Surgery.—The application of Prof. Röntgen's radiations to the purpose of surgical examinations has been very generally taken up both in England and abroad, and with results which, as far as they go, are decidedly promising. The subject is, however, one that is interesting rather to the surgeon than to the electrical engineer. It must necessarily be some time before the experience and knowledge necessary for the successful manipulation of the Röntgen rays for this purpose can be acquired and spread among the medical profession. Meanwhile, it is interesting to note that Dr. Oakley, of Halifax, in a letter to the *Lancet*, has called attention to the fact that common light from an ordinary incandescent lamp can very frequently be used with advantage in surgical work. "I have used it," he says, "constantly during the last 10 years with very satisfactory results, both in the detection of foreign bodies and malformations in the hand, foot, nose, ear, and wherever, in fact, it is possible to render a part sufficiently translucent. I have frequently demonstrated this to friends, and also at the annual meeting of the Yorkshire branch of the British Medical Association held at the Halifax Infirmary four years ago. I do not think the use of the light in this manner is sufficiently well known. For ordinary work I use the small throat lamp, but for deep penetration a larger, placed in a small dark chamber, so that the whole of the light shall be concentrated on the part to be illuminated."

Rontgen's Radiations.—The Americans, who began by disbelieving in the new photography altogether, have now taken it up with avidity, and the technical Press is full of it. The American non-technical Press has also found it a convenient field for displaying its usual characteristics. Up to the present, however, little appears to have been done except to repeat the experiments made in Europe, and fully described. Another branch of work entered upon with much energy has been the looking up of old papers with reference to vacuum discharges, with a view of showing that somebody knew all about it a long time ago, only he did not take any photographs. That is a branch into which it is not intended to go here. So far as any real determination of the nature of the new radiations is concerned, little progress has been made. Their marked action on the electroscope is still being investigated, and it has been suggested that this supplies a readier means of indicating their presence than the tedious method of exposing a photographic plate. The results obtained have been to some extent discordant. This may possibly arise from the different tubes used giving radiations of different qualities, or, let it be said boldly, of different wave lengths, although up to the present there has been no proof of the existence of a wave either longitudinal or transverse. Some experiments of Prof. Righi may, however, have some bearing on this point. In this case a charged metallic disc was used having in front of it and very close a metallic network in electrical communication with the earth. On this apparatus ultra-violet light had a decided action, in so far as it tended to disperse a negative charge on the metal plate and originate a positive one, while the Röntgen rays discharged both positive and negative charges alike. If the vibration is longitudinal, it is almost certain that the transmission must be very rapid, and the wave, therefore, a comparatively long one. It might be worth while to ascertain if it could not be measured directly.

Units and Dimensions.—A paper read by Mr. T Proctor Hall before the Iowa Academy of Science on the subject of unit systems and dimensions is published in the *Electrical World*. Mr. T. Hall shows that the C.G.S. system is itself an arbitrary one, since the gramme depends upon the earth's attraction for water. He contends that a relation which by definition fixes the value of a unit should, if possible, apply to all quantities to be measured by that unit, and that the law of gravitation, which most nearly satisfies that condition, if chosen as a base, enables a system to be constructed having only two fundamental units—the second and the centimetre. In this case, mass is eliminated for the reason that as unit mass is that mass which produces at unit distance unit acceleration, its dimensions are in terms of those of distance and acceleration—that is, of length and time only. Pursuing this method a step further, if the properties of the ether are used as a base, only one dimension is needed, since in ether waves there is a fixed natural relation between length and time, and, therefore, the latter unit may be derived from the former. In this system the disparity between the dimensions of the electrostatic and electromagnetic units should disappear. With regard to this it may be remarked that the ether is a more or less hypothetical substance invented to fulfil certain requirements and liable to alteration as these become more defined. Just now, for instance, it is in question whether it should not be given an entirely

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new property of volume elasticity. When it is added that a particular condition — namely, a wave-length *in vacuo*—must be stipulated for, it does not seem that a system on this basis would be much less arbitrary than one based on the weight of a known substance like water. But, practically, if the system of units is to be changed every few years no one will ever understand it at all. Even such a simple matter as the difference between mass and weight has given difficulty in times past. It would be eminently undesirable to reintroduce that confusion.

Mechanical Traction.—Mr. Angelo Fahie, M.I.E.E., has contributed an article on "Mechanical Traction" to the *Freeman's Journal*. In view of the proposals of the Dublin United and Dublin Southern Tramway Companies, the subject has at present a particular interest for the citizens of Dublin. Starting at once the question of what is the best system of traction, Mr. Fahie says that steam, having had a fair trial and being found unsuitable, may now be considered out of competition, and the problem, therefore, is narrowed down to a contest between the rival claims of electric and cable tractions. The cable system, although somewhat simple, is not by any mean suitable where sharp angles and numerous curves are to be encountered, and amongst formidable objections to it are the enormous cost of construction and the presence of the continuous open slot. As to the efficiency of the system, we have too few cable roads in the United Kingdom to enable us to arrive at any definite conclusion. The best cable roads at present in operation in England are those in Edinburgh, Birmingham, and on the Brixton-road, London. Examples of the system are, however, numerous in the United States, notably the San Francisco, Chicago, and Kansas City lines. In competition with the cable system there are three forms of electric traction to be considered—namely, the overhead, the accumulator, and the underground or conduit system. Of these methods, the first, or overhead trolley wire, appears to be the one which has proved most adequate to the varying conditions of a street tramway service. It must not be assumed, however, that the overhead trolley system is perfect. Its great disadvantage is the unsightliness of the overhead wire, and the necessity of carrying poles, features which would render the introduction of the system to crowded thoroughfares extremely difficult and unsightly. No matter how well planned a tramway line on the trolley system may be, the presence of poles and overhead wires interferes more or less with the æsthetic appearance of city architecture, and, moreover, there is always the danger of a possible impediment to the movement of fire-escapes. On the other hand, an underground or conduit system is not only exceedingly expensive, but it reintroduces the continuous slot, which was one of the objectionable features of cable traction. Lastly, Mr. Fahie refers to the closed-conduit system of the Westinghouse Company, in which there is nothing but a series of contact-pieces projecting slightly above the roadway. "With such an arrangement there is no unsightly overhead trolley wire, and no objectionable open slot in the roadway. The presence of the contact-pieces cannot be regarded in any way objectionable or dangerous, as they project only about half an inch above the surface and present a convex face to the traffic, the edge being flush with the road; the face is also corrugated, so that there is no chance of horses slipping on them." In conclusion, Mr. Fahie strongly urges that this system should be given a trial, at all events in some of the more crowded parts of Dublin, before the city is completely surrendered to the overhead trolley system.

Fuses.—A report submitted to the Philadelphia Board of Fire Underwriters by Mr. W. McDevitt has appeared in full or abstracted in several of the American electrical papers. Mr. McDevitt, apparently, is not one of those persons who are afraid to say plainly what they mean, for he entitles his report, "The Gross Untrustworthiness of Fuse Metals and Appliances as a Means of Protection for Electric Circuits." Mr. McDevitt says that, in spite of the change from wood to porcelain and repeated alterations made from time to time in the terminals, screws, distances between terminals, etc., fuses continue to give trouble. Instances have occurred where the line, although properly fused, has been seen to give off smoke, followed by the virtual roasting and destruction of the insulation. Investigation proved that this was due solely to the sluggish action of the fuse when the circuit was either overloaded or short-circuited. Alloys of different compositions have been used. Some chemical change takes place, either from oxidation or action of the current, resulting in variation in fusing current required. Mr. McDevitt adds: "The gross unreliability of fuse metals, and the lack of dependence to be placed upon the best-designed fuse-blocks used in practice, has forced me to the opinion that in all cases of over 10 amperes capacity, fuses and their appliances, while generally operating as desired, under certain conditions, however, are a serious fire risk, not only in themselves, but in their failure also as a protector." In support of this a large number of tests made in Philadelphia last January are set out, and these are fortified by the opinions of several American electrical engineers on the subject. It is claimed that it is established by these that fuses may carry 50 to 200 per cent. in excess of rated fusing current, or may be so sluggish in action as to be practically useless. Fuse metals made of alloys, so as to have a low temperature melting point, will maintain at a red heat, making a serious fire risk, while metals such as copper, aluminium, iron, etc., are not adapted for fuses, owing to the high temperature required for fusing. In fact, fuse metals are generally unreliable, as their position, length, age, oxidation, shape, composition, temperature, terminals, all affect their fusing point. No standard fuse-block and fuse could be established without some of the above factors causing a variation in the result. The remedy suggested is nothing less than the entire abandonment of the fuse and the substitution of an automatic magnetic circuit breaker, at any rate, in all circuits carrying over 10 amperes. Mr. McDevitt says that during the last few years as a substitute for fuses automatic magnetic circuit breakers have been adopted in power transmission, railway work, isolated lighting plants, and storage battery installations, independently of any requirements of boards of fire underwriters, as engineers have long realised by practical experience the untrustworthy character of fuse metals; and the report concludes by specifying the requirements of an "approved" circuit breaker. Such a circuit breaker would have the features of opening the circuit in less and less time as the conditions of the circuit protected approach a short-circuit—that is, have an inverse time element. The electromagnetic part of the circuit breaker would be designed to develop more energy than is necessary to trip the retaining catch, and the additional energy developed should be applied directly to aid in opening the switch. No springs would be used in adjustment, and all bearing pins and parts liable to be affected by corrosion or rust would be of phosphor bronze, and the moving iron parts copper-plated; while, lastly, the armature or plunger of the magnetic circuit breaker must not act on the retaining catch or switch arm unless a free preliminary movement precedes such action.

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ISLINGTON ELECTRIC LIGHT STATION.

The parish of Islington has been the field of much controversy over electric lighting questions. The history of the various attempts of companies to obtain a monopoly in the district is contained in the full report of the Electric Lighting Committee to the Vestry in 1893. Mr. S. Lambert, the chairman of the committee then and now, has been throughout the mainstay of the movement for securing the undertaking to the Vestry. The numerous schemes for lighting the parish previous to 1892 may be briefly summarised as follows:

In 1882 the Metropolitan (Brush) Electric and Power Company applied for and obtained a provisional order from the Board of Trade, but it was subsequently revoked by the Board, as the company did not proceed to work their order. The then Lighting Committee also obtained tenders for lighting parts of Upper-street, but wisely decided to postpone the matter. In 1890 Mr. W. Beale made application to the Vestry for permission to lay electric lines under the footway in the Holloway-road from his premises to the Nag's Head public-house, with a view to supplying the electric light to certain premises abutting on such footway. This application was granted by the Vestry solely as a highway authority. A further application by Mr. Beale for permission to fix 18 arc lamps on the footway on the north-east side of Holloway-road, and to lay the necessary mains for the purpose of supplying electricity to such lamps was granted by the Vestry, and an agreement embodying the conditions imposed by the Vestry in acceding to these applications was entered into. It soon became apparent, however, that the undertaking in the Holloway-road was in reality being carried out by Messrs. Sharpe and Kent, who sought to have the agreement with Mr. Beale assigned to them, a course to which the Vestry did not agree. These gentlemen at the same time applied to the Board of Trade for a provisional order empowering them to light the whole of the parish, but it was not granted, as the consent of the Vestry could not be obtained.

The Camberwell and Islington Company had in the meanwhile obtained an order, but nothing came of it owing to the want of financial support. A committee to consider the advisability of the Vestry undertaking to erect their own electricity supply works was appointed in January, 1892, and obtained advice on the subject from Prof. Henry Robinson. That expert advised the use of the low-tension system, with two generating stations, at a cost of £85,000, to light 24,000 lamps simultaneously. Prof. Robinson also advised that the current could be produced at a cost of 4¾d. per unit, which would permit of it being sold at 5d., but that during the first year's working, at any rate, it would be wise to charge the consumer 6d. per unit; at 5d. he calculated that the cost of the electric light would be about the same as gas charged at Islington. With regard to street-lighting, the professor advised that the cost of lighting a street with arc lamps would be greater than the cost of lighting it by gas, but that if the comparison were made on the basis of light for light the result would come out distinctly in favour of electricity. He strongly advised the Vestry to preserve in its own hands the right to supply electricity in the parish, and so prevent the creation of another monopoly like gas and water. On the advice of the committee, the Vestry obtained a provisional order. The Electric Light Committee then appointed a sub committee to visit various electric light stations and to report as to the best means of supplying the parish. They prepared a most exhaustive report from the information gathered, and showed a thorough appreciation of the advantages of the alternating-current high-tension system for Islington. The final recommendations of the committee were as follow:

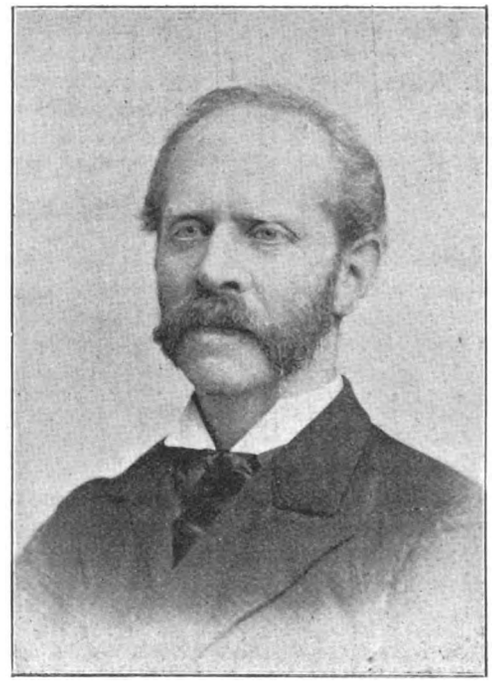
1. That the supply of electric light can no longer be regarded as a speculative business, but, on the contrary, must be admitted to be an undertaking of great benefit to the public and of assured commercial success.

2. That so soon as the Islington Electric Lighting Order, 1893, has been granted by the Board of Trade and confirmed by Parliament it is expedient in the interest of the parishioners that the Vestry should take the necessary steps to carry such order into effect.

3. That it would be both undesirable and expensive to have more than one central station for the supply of electricity in the parish, and that it is desirable to secure a site as central as possible and of sufficient capacity to permit of future extensions.

4. That the high-tension alternating-current transformer system is best adapted for private lighting in a parish of so large an area as Islington, inasmuch as the capital expenditure required for this system would be far less than that of the low-tension or any other recognised system, and on the ground that outlying or scattered parts of the parish could be supplied without much additional outlay (compared with the low-tension system) and without any appreciable delay so soon as the demand for the light in such outlying or scattered districts justifies such extension.

5. That the high-tension continuous current is most suitable for arc lighting in the public streets.



MR. S. LAMBERT, CHAIRMAN OF ELECTRIC LIGHT COMMITTEE.

6. That immediately a site has been obtained, a station be erected suitable for an installation capable of serving 20,000 lights of 8 c.p. burning at one time and about 80 arc lamps for public street-lighting, the Electric Lighting Committee to have discretionary power as to the capacity of the plant to be from time to time laid down until the said total capacity of 20,000 8-c.p. lamps and 80 arc lamps is provided for.

7. That the special committee be authorised to obtain plans, specifications, and tenders for the work and to select an electrical engineer to prepare such plans and specifications on terms to be approved by the Vestry.

8. That a loan of £60,000 be obtained for the purchase of site, erection of building, and the provision of the necessary plant and mains, such loan to be taken up in such sums as may from time to time be required.

9. That it be referred to the Special Electric Lighting Committee to carry the foregoing opinions and recommendations into effect, subject to the consent of the Vestry to the purchase of a site, the designs for works, the appointment and remuneration of an engineer, and to the mode of borrowing being first obtained.

The Vestry adopted the recommendations of the committee, and in July, 1893, appointed Mr. Albert Gay as their engineer to prepare plans and generally to superintend the erection of the works. Mr. Gay advised that the generating station should be erected on some ground

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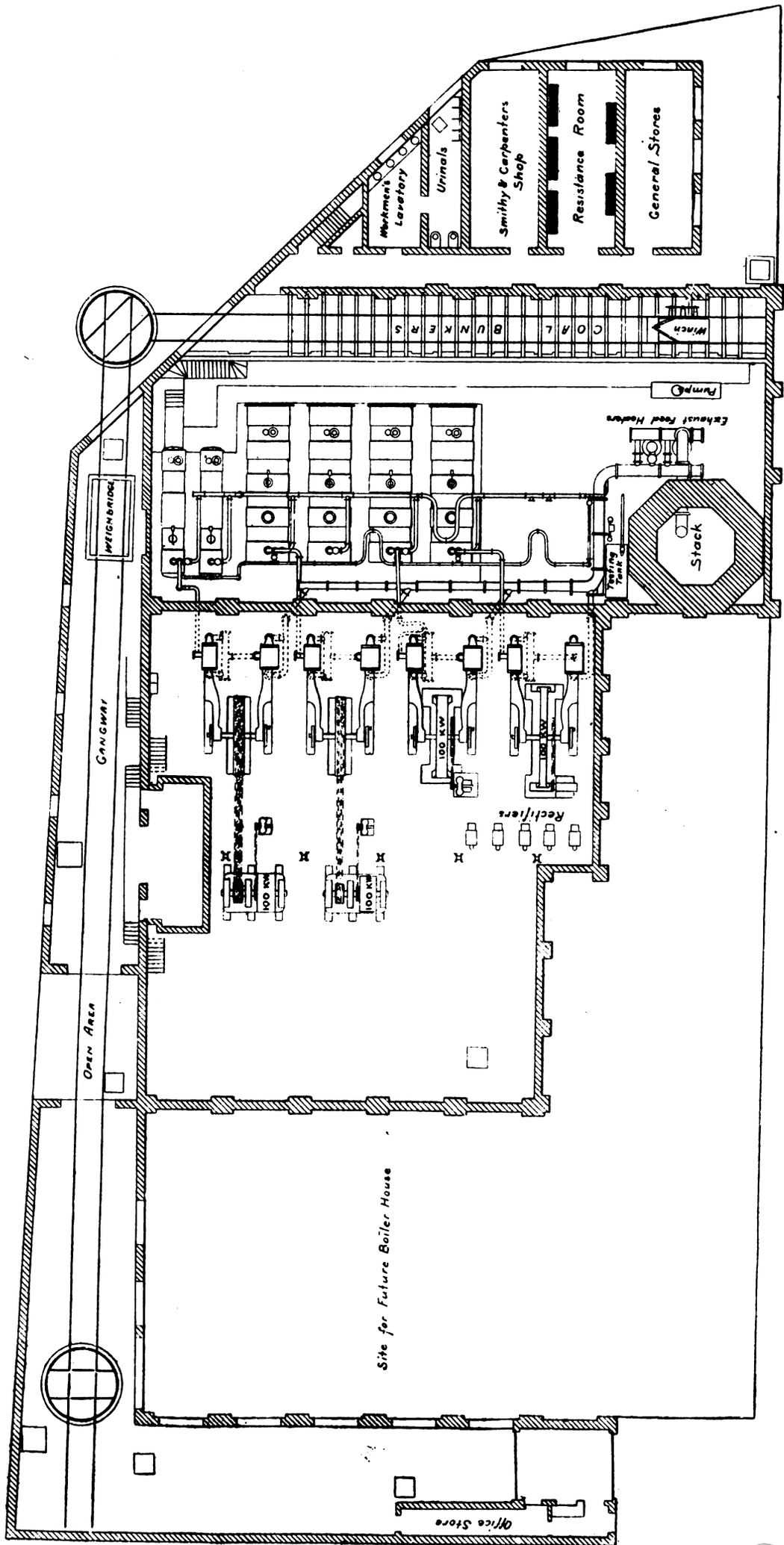

FIG. 1.—Plan of Islington Electric Light Station.

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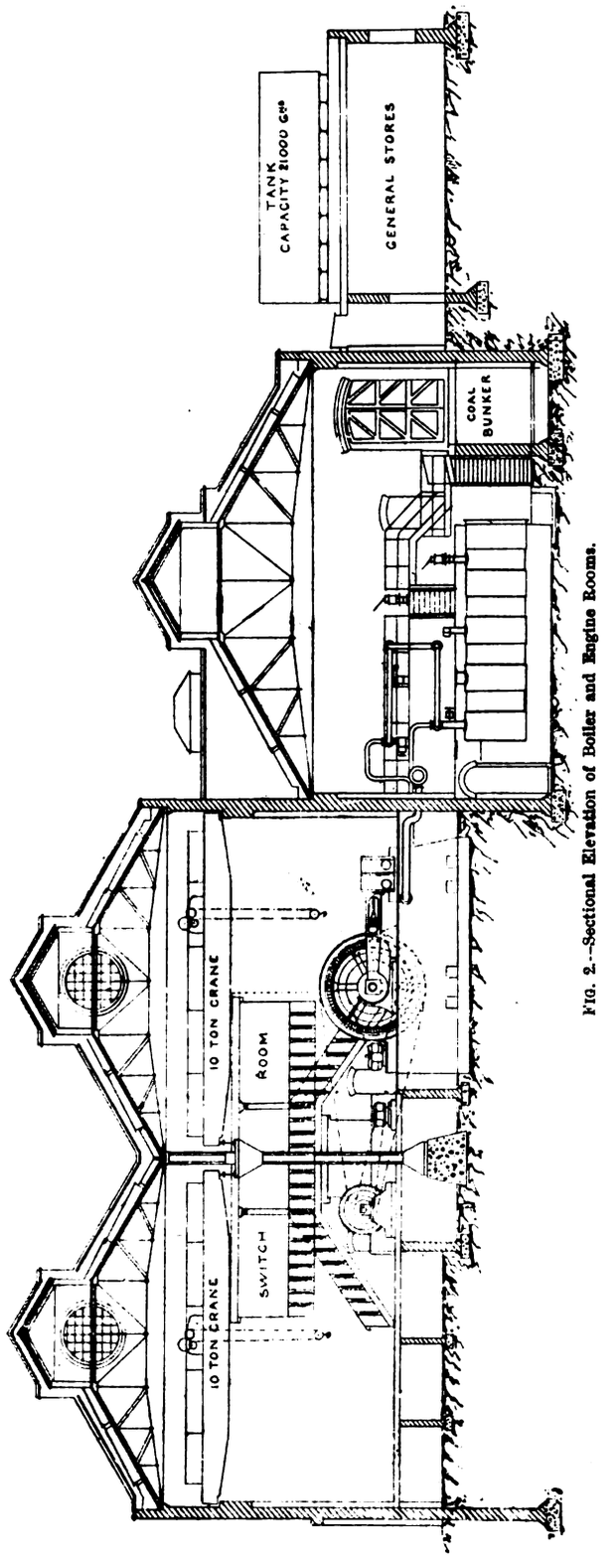

FIG. 2.—Sectional Elevation of Boiler and Engine Rooms.

in Eden-grove adjoining the Great Northern Railway. This position gives great facilities for obtaining coal in quantity, as a siding has been made into the boiler-house. The coal is thus delivered directly into the bunkers. The necessary land, amounting to about three-quarters of an acre, was bought from the Great Northern Railway Company for £9,000, and an additional £257 was paid for the siding. Mr. Gay then prepared specifications for the machinery and mains, while the building specifications were drawn up by Mr. A. H. Tiltman, F.R.I.B.A., for an estimated cost of £17,542. After careful deliberation the following tenders were accepted:

Macfarlane, buildings	£22,785
Morland, structural ironwork	1,944
D. Adamson, Lancashire boilers, engines, travellers, steam-pipes, etc.	8,614
Babcock and Wilcox, water-tube boilers	1,170
J. Fowler and Co., alternators, exciters, and main switchboard	3,925
Elliott Bros., testing apparatus and instruments	830
British Insulated Wire Company, street boxes, pipes, and conduits	£4,333
India Rubber and Gutta Percha Company, cables	7,209
S. Z. de Ferranti and Co., alternator and arc-lighting plant, including rectifiers and switchboard	4,577
S. Z. de Ferranti and Co., transformers	2,128
Chamberlain and Hookham, meters	—

General Arrangement.

The arrangement of the buildings and generating plant can be seen in plan and elevation in Figs. 1 and 2. The general view of the station from the switch gallery is shown in Fig. 3. As will be gathered from these illustrations and the contract price, the buildings are most extensive and substantial. The idea throughout has been to keep extensions in view, although we do not consider it right to penalise a new station with such a heavy building charge. Thus the Islington Vestry have spent nearly £25,000 on buildings only, and yet it is likely that more building will be done directly extensions are started. Commencing with the boiler-house, it will be noticed that the space has been excavated so that the boilers are wholly below the level of the surrounding ground, and also below the engine-room floor. This arrangement has two advantages. The coal can be brought in trucks directly from the colliery on to the rails over the coal-bunkers. There the trucks are up-ended by the apparatus illustrated in Fig. 4, and coal falls through the truck into the bunkers. The floor of the bunkers is on the same level as the stoking floor, and hence very little handling of coal is required. The longitudinal wall between the charging floor and the bunkers is arched, and has a number of openings through which the coal can be taken to the boiler. The engine-room floor is higher than the top of the boilers (as can be seen in Fig. 2), so much so that the steam-pipes rise from the boilers to the engines, all connections being made below the floor line. The engine-room consists of two large bays, each having its own traveller, but the two rope-driven plants come into the space, which otherwise would only be required for extensions. The general design for the extension of the station is as follows: The present shaft, which is 192ft. high, 14ft. 6in. diameter inside at the bottom and 12ft. at the top, is amply large for several more boilers. These will be placed in the present boiler-room, and when that is full a new boiler-room will be erected beyond the chimney, and the engine-room will also be extended. This extension is that likely to be carried out first, and will involve more building changes, as stated above. After this new wing is added and filled, a third boiler-room will be constructed in the space, shown in Fig. 1, between the office entrance and the engine-room. This site, of course, necessitates a second shaft being built. The coal for this boiler-house will be conveyed by the rails showing in the plan. The switch-gallery accommodation will, however, be ample for further use.

The two overhead travelling cranes were made by Messrs. Craven Bros., of Manchester. They are for rope power, and each to lift and travel a safe working load of 10 tons over a span of 41ft. 3in. The cranes were included in Messrs. D. Adamson and Co.'s contract for the steam-engines and boilers. To enable the cranes to be worked before the steam power was available to lift the parts of the steam-engines, provision was made to work them by hand by endless chains working on chain pulleys on the motion shafts of the cranes, the endless chains hanging down within reach of the men on the floor. Now the steam power is available, the driving ropes for both cranes are worked from a small fixed steam-engine in the mechanics' shop, which also drives the machine tools. The long chains for working by hand were taken off, but are available in case they might be required again. The motions are now controlled by eight ropes hanging from the cranes, with handles for putting the motions in and out of gear. Both cranes are driven by their own rope, so that they can be worked independently, and when they are not required the driving rope is stopped by a Snyers friction clutch on the intermediate driving shaft. Messrs. Craven Bros. also made for the same contract a very good device (Fig. 4) for hauling railway coal wagons from the main line on to the line of rails in front of the boilers, and tipping the wagon

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by the lifting chain. The hauling and tipping frame being hooked on the draw link of the wagon lifts it endways, thus emptying a full wagon of coal without labour. The hauling and tipping motion is driven by an endless rope running along the side of railway rails, and the motions are put in and out of gear by levers on the frame. The driving rope of this is worked by the same engine which drives the endless ropes for working the travelling cranes.

Buildings.

These, as stated above, were designed by Mr. A. H. Tiltman, who does not wish to publish any details of them.

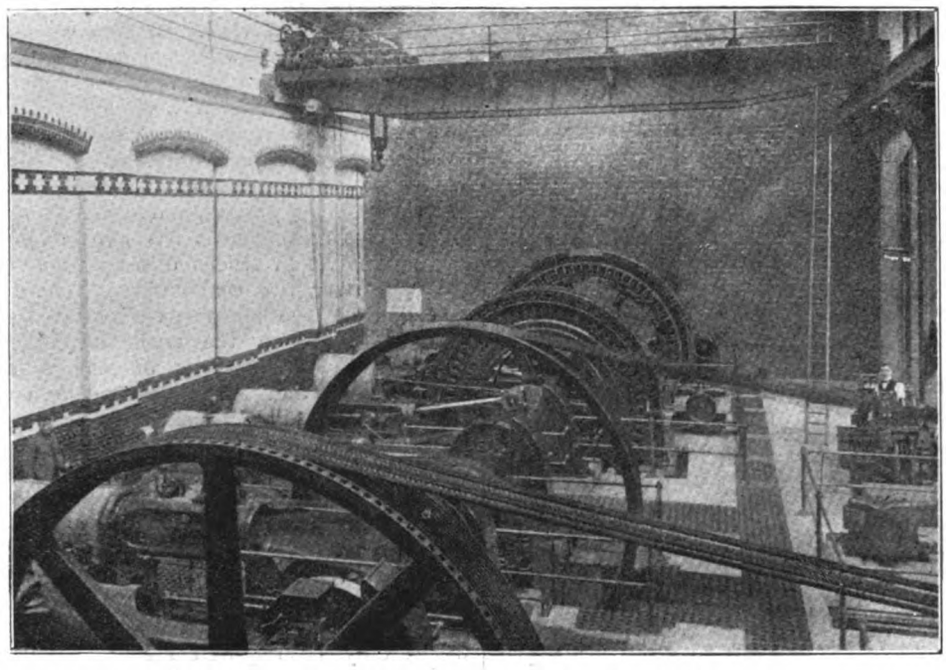

Fig. 3.—View of Engine-Room from the Switch Gallery.

The work throughout is most substantial, and the offices on the first floor are handsomely fitted in mahogany. The interiors of the engine-room and boiler-room are lined with glazed bricks, and this has been carried even to the exterior portions of the stack which are in the boiler-room. The chief objection to this part of the work is the cost; but that is a detail in the hands of the Vestry. One point, however, seems to have been overlooked, and that is, that

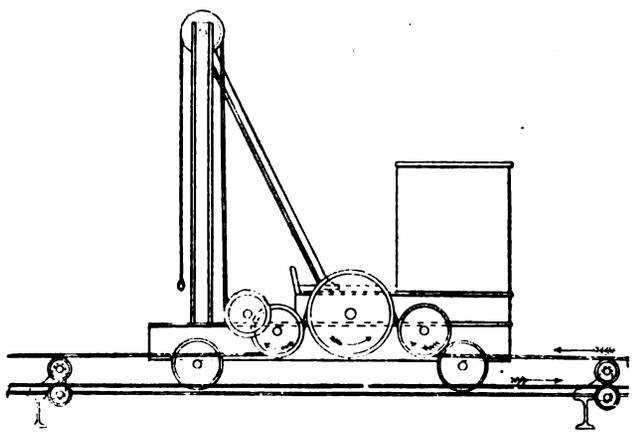

Fig. 4.—Coal Truck Hauling and Tipping Gear.

neither of the travellers can in any way assist in getting the machinery into the building from off either a railway truck or trolley. With the heavy parts required by slow-speed engines and flywheel alternators this is a decided necessity.

Boiler-House Plant.

In this department Mr. Gay is to be congratulated, in that he has combined the advantages of the Lancashire boiler with those of the water-tube type. The present plant consists of four Lancashire boilers and two Babcock-Wilcox boilers. The four Lancashire boilers, of Adamson's latest type, are each 28ft. long by 7ft. 6in. diameter, and suitable for a working pressure of 150lb. per square inch. The boilers throughout are built of the best mild steel. The whole of the rivet holes are drilled and machine riveted with steel rivets. The boilers are fitted with a full complement of mountings and fittings in duplicate. All these boilers and the two Babcock and Wilcox water-tube boilers are fitted with the "Meldrum" patent forced-draught furnaces, which are now being very generally adopted for electric supply stations. In this way the power of the boilers can be largely increased when the full duty is required from the electrical plant. We have before briefly described the action of these furnaces at Stafford and elsewhere, and it is only necessary to add that it is no uncommon thing for these furnaces to give a combus tion of 40lb. of coal per square foot of heating surface This fact alone, when fully recognised, will, we think, tend to the still more extensive adoption of these furnaces by electrical engineers, as it is evident that an electric supply station where the boilers are only fully worked during, say, three or four hours in the 24, any such special means for getting extra duty out of the boilers will materially reduce the steam plant required. What we might term the only objection to this system of forcing the boilers—viz., the noise created by the blowers—has been overcome by the makers, as will be seen by the block (Fig. 5), whereby the air is obtained through conduits leading from beneath the foot-plates, thus effectually deadening the sound, with the further advantage of preventing coal dust, etc., being carried into the blowers when the fireman is cleaning or feeding his furnaces. This refers to the Lancashire boilers, but we find the Babcock and Wilcox boilers are without this improvement. The blowers under these boilers consequently make rather a noise. These furnaces will give the engineer great command over his steam-producing plant when a sudden fog arises, and also will reduce the cost of working, as a lower-class fuel can be burnt at ordinary loads.

Steam-Pipes.

The arrangement of the steam-pipes is, we believe, a novel one, and certainly is to be commended. The view of the top of the boilers (Fig. 6), in conjunction with the general plan of the station (Fig. 1), will enable the system to be understood. In the first place, a pipe is taken from each engine to a boiler. This pipe, which is of ample dimensions to supply the engine, is carried back beyond the boiler connection and then connected past a valve to an equalising pipe. This equalising pipe can then be used to supply any engine if its individual boiler is shut down, or it can and will usually supply the excess of steam

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required by the engine over its individual boiler production. It will be seen that at present there are six boilers and only four engines, so that one boiler feeds into this equalising pipe only. The dimensions of the largest steam-pipe is thus kept down to a smaller limit than with the ring-main system. An equal degree of safety is also secured with a fewer number of valves.

All the steam, feed, blow-off, and other pipes were supplied and erected by Messrs. D. Adamson and Co., and are arranged in duplicate. The pipes are of forged mild steel fitted with strong cast-iron flanges, and all joints are simply made with ordinary cement. The exhaust steam from all the engines is delivered into the main chimney stack by a forged mild-steel riveted-up exhaust-main, and provision is provided so that the exhaust may be taken either direct into the stack or through feed-water heaters. A complete set of by-pass arrangements, both for feed and exhaust, with the necessary valves, has been provided for this purpose. The feeding of the boilers is also provided for, either by duplex pumps or injectors, in duplicate feeding direct. Every means has been provided throughout so that in the event of any portion of the system being required to be shut off, it is possible to keep running with the remainder of the plant.

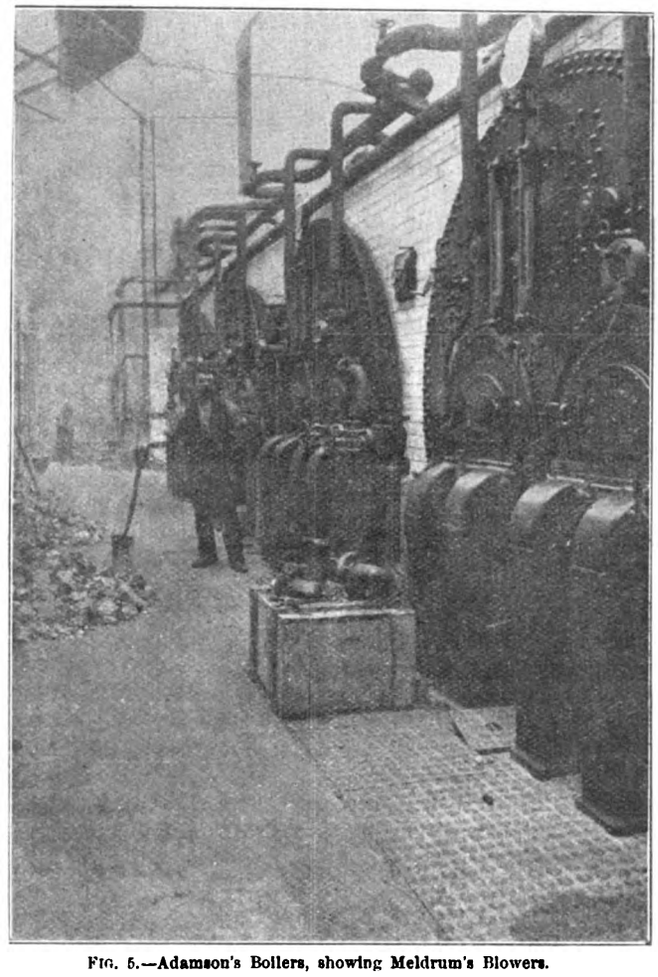

FIG. 5.—Adamson's Boilers, showing Meldrum's Blowers.

STEAM-ENGINES.

The four engines supplied by D. Adamson and Co. (Fig. 7) are of the horizontal, high-pressure, compound, non-condensing type, with cylinders arranged side by side. The high-pressure steam-cylinders are 15in. diameter, and the low-pressure cylinders are 24in. diameter, each having a 3ft. stroke. They run at 95 revolutions per minute, giving a piston speed of 570ft. per minute. Both the cylinders are steam-jacketed, with high-pressure steam direct from the boilers, the jackets being coupled with suitable valves and connections to an automatic steam-trap. The engines are intended to develop from 200 i.h.p. to 225 i.h.p., with a steam pressure ranging from 125lb. to 150lb. at the cylinder. The cylinder bodies and covers are lagged all over with non-conducting composition, and neatly finished with planished sheet steel and brass hoops; they are also fitted with a full complement of spring relief valves, drain and indicator cocks. The valve gear fitted to both cylinders is of the latest improved Wheelock type. The system is that of having the valve seats independent of the cylinder castings themselves. The valve seats are made in the form of a plug, which contains both the steam and exhaust valves. The valves are of the flat grid type, with multiplicity of opening and short travels. The high-pressure valves are directly and automatically controlled by a high-speed governor, driven by ropes from the main shaft of the engine, whilst the low-pressure valves are fitted with an expansion gear arranged to be regulated by hand whilst the engine is in motion. The crankshafts are of forged mild steel, and are 8in. diameter in the journals, and the journals are 18in. long; they are fitted into brass steps lined with magnolia metal. The engine cross-heads are of mild cast steel, fitted with loose cast-iron slippers running in bored guides in the engine frame. The cranks are of the disc type, polished all over, and of mild cast steel, and fitted with mild-steel crank-pins 6in. diameter by 6in. long. The connecting-rods are also of forged mild steel, and are fitted at each end with adjustable steps, the brass shell steps being lined with magnolia metal. The piston rods are also of mild forged steel, and are 3¼in. diameter. From two of these engines the alternators are driven by means of ropes from the engine flywheel. The flywheels are 14ft. diameter, and are turned on the rim for 10 ropes 1¼in. diameter. The other two engines are fitted respectively with a flywheel alternator—one by the Leeds and London Electric Company, and the other by Messrs. S. Z. de Ferranti, Limited. The engines generally are complete with automatic lubricators for every part, so as to ensure continuous running. Oil splash guards and oil-collectors are fitted round wherever possible, all the waste oil being led by an arrangement of pipes to the oil-tank in a convenient place in the engine-room, where it is refiltered for further use. The whole of the bearings in the engines, alternators, etc., are also fitted with a cold-water service,

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coupled direct to the City mains. All the alternators and dangerous parts round about the engines are also fenced with polished rails and cast-iron standards.

ALTERNATORS.

There are at present four 100-kilowatt alternators in the station. The first two (Fig. 8) are rope-driven, at a speed of 375 revolutions per minute. They all are wound to give a pressure of 2,050 volts. The two rope-driven plants and the first flywheel alternator were supplied by J. Fowler and Co., of Leeds. The first named are of the usual type, having revolving field magnets of laminated iron. The armature core is constructed so that any section with its coil can be removed in case of failure and quickly replaced by a fresh interchangeable section. The machines have three bearings. The frequency of these alternators is 50 complete periods per second.

The remaining flywheel alternator was supplied by Messrs. S. Z. de Ferranti and Co. It is of the same type as the large alternator supplied by that firm to Portsmouth, but several modifications and improvements in detail have been made in it. As a consequence, the alternators are practically silent when running. The alternator has been designed with a stiff field and small armature reaction, so that the machines may work well with the rectifiers and their motors. The alternator has a large air-gap to get these results, which, of course, necessitates a slight increase in the excitation. The field-magnet system is built up on the flywheel of the engine, radial poles being inlet into the rim. These poles are wound with bare copper strip on edge, with insulation between the adjacent turns. The armature consists of a series of wedge-shaped segments built up of laminated iron. The plates have holes punched in them, through which the conductors are wound. The complete segments are then bolted individually in place on the cast-iron frame. As in all the other alternators, the exciter for this set is driven by ropes from a pulley on the alternator shaft.

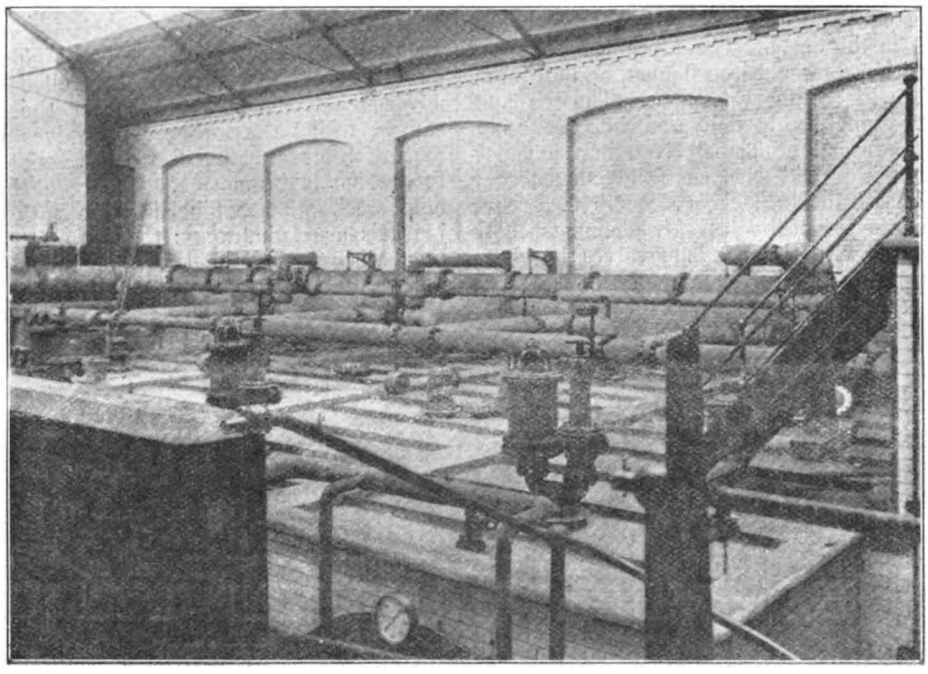

FIG. 6.—View of Steam and Exhaust Pipes.

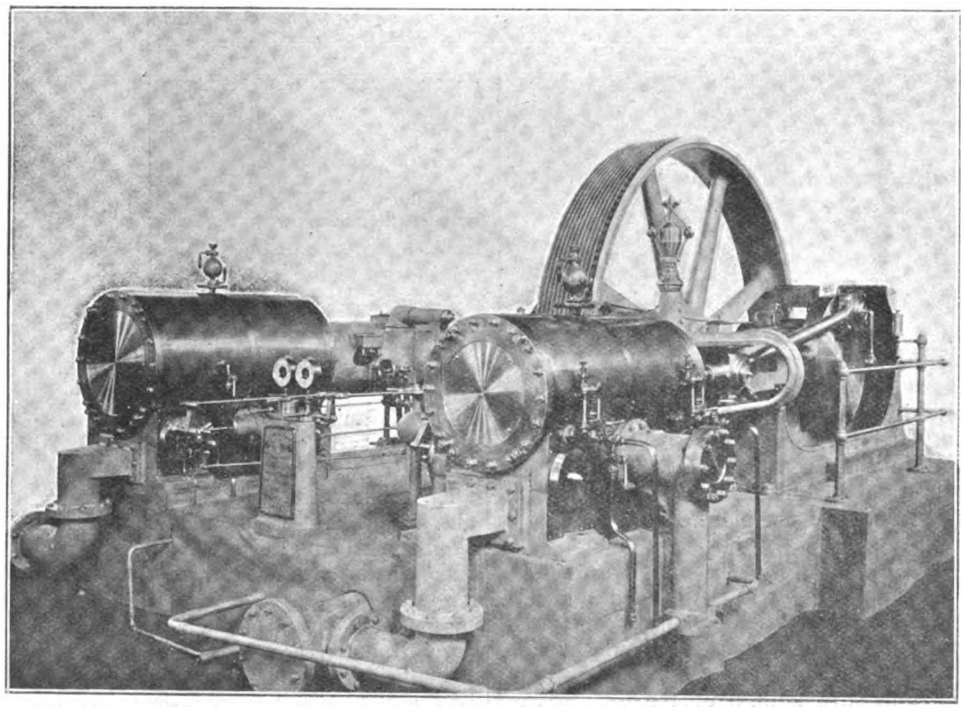

FIG. 7.—Adamson's Horizontal Engine, supplied to Islington.

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Switchboards.

These, with the exception of the arc lighting boards, were supplied by Messrs. Fowler and Co., and the instruments for them by Elliott Bros. The general position of the switch, etc., can be seen in Fig. 9. Beginning at the bottom of the board, the lower fuses are the alternator fuses, above which come the ammeters in the alternator circuit. In the next case are the alternator switches, which are of the well-known plug type. Above these are the electrostatic voltmeters, of which only four are fixed at present, one for each alternator. Above these come the circuit switches, ammeter, and fuses respectively. The pillars in front of the board carry the rheostat regulators for the exciting circuits, with ammeters and voltmeters. Each exciter is strictly kept to its own alternator, and no means of inter-connection are provided. Thus, a breakdown in an exciter will render the alternator *hors-de-combat* as effectually as if it was burnt out. The alternators are arranged for working in parallel, but the synchronising panel cannot be seen in the illustration.

Messrs. Elliott Bros. also supplied a complete test table equipped with all the instruments for testing cable, conductor, and insulation resistance, and capacity, etc. All the instruments, except the galvanometer, are mounted on a strong teak table. The galvanometer is fitted in a swinging frame, so arranged as to be unaffected by vibrations. The other apparatus consisted of a photometer, speed and pressure indicators and recorders, steam-engine indicators of the Wayne high-speed type, recording voltmeters, and a non-inductive resistance for use as an artificial load.

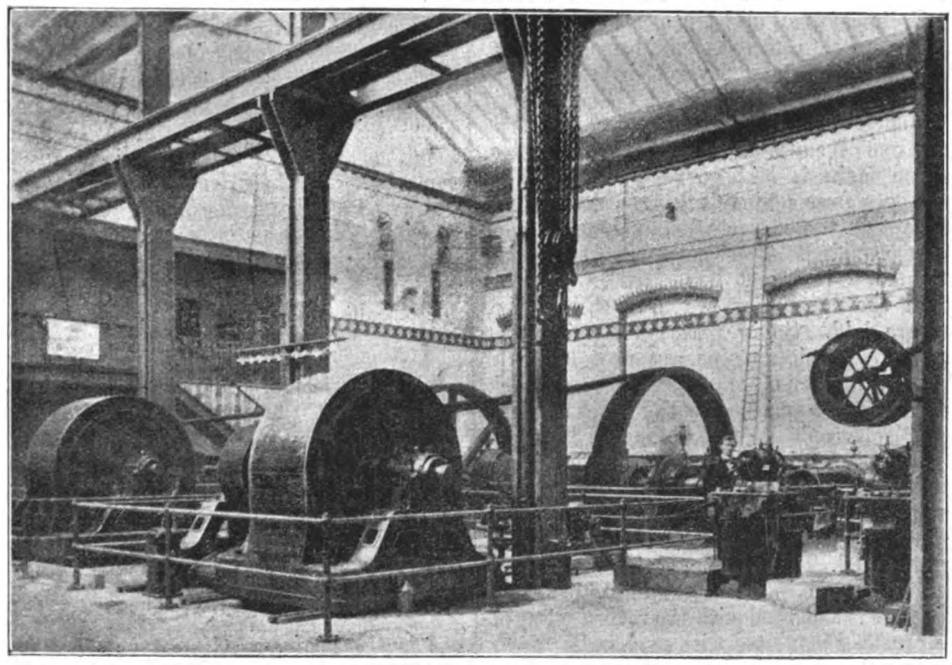

Fig. 8.—View of the Rope-Driven Fowler Alternators and Ferranti Rectifiers.

Arc Lighting Gear.

This has all been provided by Messrs. Ferranti and Co. There are at present five rectifiers, each capable of supplying 30 arc lamps; four of these are for use and one is spare. The switchboards are so arranged that any rectifier can supply one arc circuit. The construction of the rectifier and the constant-current transformers was fully described in our Tunbridge Wells issue of October 4, 1895. The arc lamps used are of the Crompton-Pochin type, and 96 are

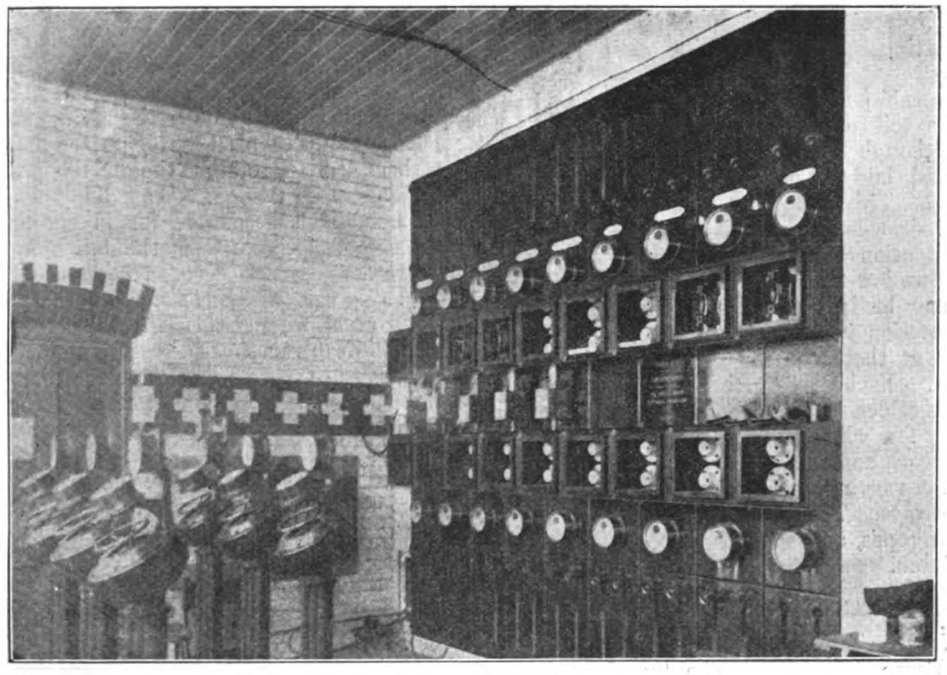

Fig. 9.—Islington Switchboards.

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now fixed and ready for running. The circuits are arranged one for each side of the streets lighted, so that half the lamps can be switched off at midnight and yet a uniform distribution of light be obtained. The lamp columns were manufactured and supplied by Messrs. W. Macfarlane and Co.

Distributing System.

The cables at present laid in Islington extend about 1½ miles each way from the station. They reach from Eden-grove along Holloway-road and Upper-street, past the end of Essex-road, nearly to the Angel in one direction, and along Holloway-road and Seven Sisters-road to Finsbury Park Station in the other direction. There are at present no branch mains or feeders, and the system is the old and elementary one of supplying long mains from one end. A high-tension main is laid on each side of these roads, and each of these four mains is kept quite distinct from the other except at the extreme distant point, where connectings links are provided. The consumers are supplied from transformers placed in street boxes under the footpaths. Then, when the consumers are near each other, low-tension mains are laid. So in parts of Upper-street some 1,000 yards of low-tension mains are now laid and supplied at points by a number of transformers in parallel. The whole of the cables were supplied by the India Rubber, Gutta Percha, and Telegraph Works Company, Limited. The high-tension cables vary in size from $^{19}/_{18}$ to $^{7}/_{16}$, and are of the concentric type.

The conductors are of strand composed of copper wires of 100 per cent. conductivity by Matthiessen's standard, each wire being carefully tinned. The whole are laid up together, and then insulated with pure indiarubber and vulcanising indiarubber. This part is sheathed with the return wires of tinned copper, then further insulated with pure indiarubber and vulcanising indiarubber and taped over all. The whole cable is afterwards vulcanised together, then braided with hemp and sheathed with two steel tapes, and again hemp braided over all. A final coat of preservative compound is is served on. The cables specified had a total length of over 30 miles, all the joints being vulcanised. The insulation resistance per mile at 60deg. F., tested in water after 24 hours' immersion, and one minute's electrification, is not less than 5,000 megohms between conductors for the high-tension cable, and 2,500 megohms over all. The low-tension cable had an insulation resistance of not less than 600 megohms between conductors, and 300 megohms over all. The high-tension cables, after being tested with 5,000 volts alternating, showed no falling off in insulation resistance.

The low-tension cables are of $^{19}/_{14}$, and are armoured and laid direct in the soil under the footpaths. The high-tension cables, although armoured, are drawn into iron pipes supplied and laid by the British Insulated Wire Company, Limited. This company supplied to the Vestry all the pipes and draw-boxes, as well as the house-service boxes for the low-tension cables. These house-service boxes each provide for two low-tension mains in parallel, so that the second one may be laid and coupled up subsequently to the first. Provision is made in each box for disconnecting the mains at that spot, for testing or jointing on further customers. Each box further provides for four concentric service cables, each with separate clamps and double-pole fuse. The whole service box is provided with a telescopic framework and surface cover, so that allowance can be made for the varying depths of the cables below the surface of the footways. The arc lighting mains are drawn into 4in. cast-iron pipes, and inspection boxes are placed at every lamp column.

Transformers.

The contract for the supply of these was obtained by Messrs. S. Z. de Ferranti and Co. The transformers, for the most part, are of the Ferranti automatic type, with two windings for both the primary and secondary circuits. Automatic gear is then provided, so that at light loads the two windings in each circuit are put in series. This, by doubling the number of active turns, halves the maximum induction, and reduces the iron losses to about one-third of the original value. At heavy load the circuits are put in parallel, and then the copper circuits act most efficiently. Some 20 of these automatic gears and transformers have been supplied, and about five others of the ordinary type. The output of these transformers varies from one kilowatt up to 20 kilowatts. We should unhesitatingly recommend these arrangements if the transformers were of the type manufactured, say, in 1888, but with the present high standard of efficiency in transformers we rather question if the small saving is really worth the risk incurred should the automatic gear fail.

In conjunction with each transformer is a high-tension ring-main junction-box of very excellent design. This box allows of disconnecting the main or the transformer, or of leaving the transformer on either branch of the main when disconnected. The main is bridged by heavily-insulated plugs, which, however, can, when desired, be replaced by oil break-fuses, either in case that section is suspected or for testing purposes. The connections to the transformers are made by an oil break-fuse on the high, and a plug on the earth, main. Arrangements are made in this box so that it is impossible to get into connection with the circuits, or to cause a short by dropping anything in.

Scale of Charges.

The provisional order granted by the Board of Trade provides that the maximum charge to be made by the Vestry for the actual amount of energy supplied to a consumer shall be for any amount up to 20 units 11s. 8d., and for each unit over 20 units 7d. The committee have resolved to adopt the following sliding scale of charges for the first 12 months with a view to enabling all consumers to have equal opportunities for obtaining discounts:

For the consumption of two hours per day of the maximum demand, 7d. per unit.
For the consumption of three hours per day of the maximum demand, first two hours 7d., the second hour 6d.
For the consumption of four hours per day of the maximum demand, first two hours 7d., the second two hours 5d.
For the consumption of five hours per day of the maximum demand first two hours 7d., the second three hours 4d.
For public lighting, 5d. per unit.

The average price which it is estimated will be obtained from consumers with this sliding scale is 6d. per unit.

The meters used have been supplied by Messrs. Chamberlain and Hookham, and Wright's excess demand indicators will permit of the graduation of charges being effected.

Conclusion.

Although the committee took expert advice at the very beginning, they throughout discarded the consulting engineer, by which they claim to have saved £4,000. From the figures before us, we doubt the saving, and also the statement in a non-technical contemporary that "the installation has been carried out at the lowest possible cost to the parishioners." Some £85,000 has been spent, of which only £65,000 is accounted for in the contracts. For this large sum 400 kilowatts is the maximum output, without any reserve, which gives a cost of £212 per kilowatt. Comparing this with Leicester, where flywheel alternators are also used, we find there 675 kilowatts installed at a cost of £38,700. This gives a cost of under £58 per kilowatt. We may add that the Leicester buildings are most handsomely appointed, and the details of the machinery there well carried out. Of course, much allowance must be made for the cost of the site at Islington, but a matter of £10,000 will not bring the two sets of figures within reasonable bounds. Another point worthy of notice is that the expenditure exactly equals that recommended by Prof. Robinson, and for which he could maintain 24,000 lamps alight on the low-tension system. The present machinery will only supply some 12,000 lamps simultaneously.

ELECTRICITY IN CONNECTION WITH BUILDING.

LECTURE BY MR. W. H. PREECE, C.B.

A large audience assembled at the Carpenters' Hall, Throgmorton-avenue, on Wednesday to hear a lecture by Mr. W. H. Preece, C.B., on "Electricity in Connection

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with Building." The chair was taken by Sir Arthur Arnold (chairman of the London County Council).

Sir ARTHUR ARNOLD, in introducing Mr. Preece to the meeting, said, as chairman of the London County Council, it was to him a very great satisfaction to preside in one of the halls of one of the most distinguished of the City companies and to see that hall devoted to so noble and to so useful an object. Mr. Preece was a very distinguished electrician, and a man who had been, perhaps, beyond and above all other men in the City of London, a man of light and leading among them for the last 40 years. No man certainly had rendered so great service to popular electricity in its most useful forms as Mr. Preece.

Mr. PREECE said: Sir Arthur Arnold, ladies, and gentlemen—With such a eulogistic introduction I feel that I fear that I shall not quite come up to your expectations, for it is indeed an extremely difficult task to address you on such a difficult subject as the application of electricity in connection with building. I do not know quite what you expect me to say. I do not know whether you think that electricity, which is going to do everything in this world, is going to replace bricks and mortar, or whether it is to be utilised as an economiser of labour in lifting materials and in breaking down trades' unions by disestablishing carpenters; but I am going to take this line—that inasmuch as the secrets of good health, apart from personal habits and the correct maintenance and up-keep of the human machine, are pure water to drink, pure food to eat, pure air to breathe, cleanliness in dwellings, in furniture, and in clothing, warmth and light, so I propose to point out to you how electricity in nearly all these points can aid those who desire to support and lengthen life by supplying all the particulars that I have named. Now, legislation enforces sanitation, Government inspects food products, it facilitates the supply of water, it controls the manufacture and consumption of gas, and in the same way it controls the supply of electrical energy, and this electrical energy, as well as gas, is utilised not only for the production of light, but for the generation of heat and for the supply of power. In this great city of ours we have two great powers—first, as we are here, I think I will say the Corporation of the City of London; secondly, as we have such a distinguished chairman to-night, I will say, the London County Council; and in these two bodies we have the representatives of all those local authorities who are to be found throughout the whole country; and in their hands Government has placed the control of the different powers for good as I have enumerated. Well, now, have those bodies, as a rule, carried out the functions that the Government have handed over to them? To a great extent they have. But there are instances throughout this country of great backsliding and retardation. In the City, in London, in Greater London, electricity is applied to a certain extent, but nothing compared to what it ought to be, and to what it will be. We are restricted in small communities by various causes, first of which is ignorance, and this, often wilful, is frequently due to indifference, and generally due to blindness. I know nothing in my experience more difficult than to try to convince a vestry, or a county council, or a town council with the doctrines of the benefits of electric lighting. I am met on all sides with objections, some due to conservatism—the true Conservative is the most difficult gentleman to move; the next most difficult gentleman to move is the Radical, because he thinks that we are introducing class legislation—he fancies he is asked to do something that is going to benefit the wealthy and aristocratic classes; and the next is the interested individual—the gas shareholder. Now, I find, I am bound to confess, that there is more trouble with that gentleman than any other, and as I am a pretty considerable gas shareholder myself, I have found that my friends the gas companies are terrible people to convince against their will. However, in spite of all this, in spite of the worst of all, and that is party spirit—in every community you have it; you have it in the London County Council, and our own Parliament is divided into two parties—and if one party proposes the introduction of electric light the other party is sure to oppose it, not because there is anything in it, but because the other fellow cannot do that which is right. However, in spite of all this we are going along, and we are going along splendidly. The advance of electrical industries in this country is quite equal to our most sanguine expectations. It is a common thing to find in the Press complaints that we in England are far behind anybody else, especially America. That is not my experience. I have visited America many times, and while there is no doubt that in some respects the Americans are very go-ahead, in other respects we in this country are quiet, and we are certain and we are sure; and in electric lighting in England, as applied where we want it—that is, for private purposes—we are certainly in advance of our cousins on the other side of the Atlantic. Now, the supply of electrical energy in this country rests entirely on two sources—one controlled by private enterprise, and the other in the hands of local authorities. It is a very moot question indeed as to which is the best source or the best means of forcing on this industry. In a pioneer business, such pioneer businesses as I have been associated with—and it is a remarkable fact that in my career I have been associated with the introduction of every single application of electrical energy; I was connected with the early introduction of telegraphy and of telephony, with the electric lighting, with electrical tramways, and with everything else connected with electricity—I find this, that owing to the fact, I am sorry to say, of public companies and private companies having no conscience, pioneer works are best originated and supported and started by private enterprise. When they are well fixed and well established, that is, I think, the time first for the Government to step in, in some industries, and for local authorities to take up the same position. Now, I am sure that the telegraphs would never have acquired their present position if the Government had started the industry. Competition, money-grubbing, and all sorts of causes led to the great development of this industry, and when it became a public necessity, when it became everybody's business, then properly the Government stepped in, absorbed the telegraphs, and took me into their service, and the result of the absorption has been that the telegraphic system of this country is the finest and best in this world. Now that local authorities, too, take over industries for the benefit of the whole community—water supplies, sanitary arrangements, etc.—the supply of light is, I think, the proper function of a local authority. A local authority is bound to look after the health of the community, and anything that adds to the health of the community must necessarily come within their sphere; and so it is that throughout the whole of this country we find our corporations taking up this subject of electric lighting. And what is the result? The result is that the cost of production, which regulates the cost to the consumer, is coming down, and the rate at which the cost of production is being lowered is quite astonishing to those who are watching carefully the progress of events. Of course, the cost of production regulates the price that the user has to pay. We find in this London of ours that there is great variation in the cost of the supply of electrical energy to the community. Take the City of London. In the City of London—which, unfortunately, from some points of view, is in the hands of a private company—the users have to pay at the rate of 8d. per unit; when you go to one of our outskirts (say, the parish of St. Pancras or the parish of Hampstead), there electrical energy is supplied at the cost of 6d. per unit, so that those who are obtaining their energy under the auspices of local authorities are benefited in the ratio of 8 to 6.

(To be continued.)

Holophane, Limited.—The prospectus of this Company has been issued. The Company will acquire and work the patent rights of Messrs. Blondel and Psaroudaki, the inventors of the holophane globe. The capital is £100,000 in £1 shares, of which the vendor takes 25,000 in part payment; 65,000 are now issued, and 10,000 left over for issue as further working capital. The list opens on Monday next, and will close on March 12. It will be remembered that the holophane globe is grooved inside and out in different directions, the object being to diffuse the light. A full description of the globe was recently given in our columns.

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THE

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TO CORRESPONDENTS.

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Vol. XV. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

FOR MEMBERS OF LOCAL AUTHORITIES.

The members of local authorities, unless personally interested in other directions, never have any objection to push forward objects that are looked upon with some favour by their constituents. Throughout the length and breadth of the land authorities are more and more considering the directions in which the authorities themselves should move, and not allow the work to fall into the hands of a company. One of the questions under consideration is that of the electric light, and those who are advocating its introduction are frequently seeking "tips" to assist the good work. Of course, the very best statement to make is that the experience gathered in every direction proves the work to be paying. It is not always that a new manufacturing industry pays its way during the first year, but in almost every instance the authorities have cleared during the first year all expenses, and in some cases have earned a small amount towards interest and repayment of capital. After a comparatively short period, not only do the works clear expenses, but easily return the amount required to repay capital, the success ending in reducing price or relieving rates. This phase of the question, however, is best ascertained from the many reports and balance-sheets we are continually giving. However, the success might be far greater and the benefits received all round considerably extended if this system of artificial lighting was generously and generally adopted, instead of percolating slowly downwards through large users to the smaller users of light. One great difficulty to be encountered is the feeling of a constituency that no doubt the work will pay, while individually the members of the constituency leave it to their fellows to patronise the new scheme. Mr. Jones will wait a little to see how Mr. Brown gets on, and Mr. Brown waits for Mr. Smith, so that the first patrons are difficult to get, and this makes the initial work harder, though all the time the householders are intending to patronise the light—some day. Thus advocates not only have to show that generally the work is likely to pay, but they must canvass the individual and reason him into taking current. How can he be induced to move? What arguments will prevail? It seems to us that, after cost has been discussed, sanitation is the best lever to work. No one can ignore this part of the subject. If light is essential to health, still more essential is it that the light be pure. Statistics are given stating that for the same illuminating power the comparative heat of various lights is—for electric light 14, common gas 279, sperm oil 234, paraffin candles 362, tallow candles 505; but this is not the worst—heating property may be good, but when accompanied by a vitiation of the atmosphere may be bad. A man requires for breathing purposes some 3,000 cubic feet of air per hour, a sperm candle 1,500 cubic feet, an oil lamp 3,000 cubic feet, a gas-burner (5ft. per hour) 20,000 cubic feet, so that a lamp consumes air equal to a man, as do two candles, while a gas-burner is almost equivalent to seven men. Local authorities often have to consider the lighting of large buildings, and one of the

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questions asked is how many lamps will be required. A rough-and-ready rule is to take the floor-space area in feet, and divide this number by 40, the result being the number of 5ft. gas-burners required; and, again, broadly speaking, you may assume that such a gas-burner is about equivalent to a 16-c.p. incandescent electric lamp. Many engineers would probably use a divisor of 60 rather than 40, but we prefer the divisor that gives "more light." Just one more point where differences of opinion arise, and, as we think, uselessly. In many, far too many, places ample light is obtained, then some decorative or artistic mind is brought to show how to get rid of a large part of the light. There is no material known which can be used as a shade to light or be interposed between the light and any given point without causing a loss of light. Ordinary glass intercepts 10 per cent., ground glass 30 to 50 per cent., opal globes 50 to 60 per cent., and porcelain as much as 98 per cent. of the light; hence it seems at times a pity that light is only generated to be intercepted. A good system of diffusion, with less light in the first instance, would ofttimes be better than the interception by means of various shades.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LAMP BREAKAGES.

SIR,—Our attention has just been called to a note which appeared in your issue of the 28th ult. under the heading of Worcester, wherein it is stated that the breakage of lamps at the Victoria Institute was due to their cheap quality. Will you allow us space to correct that statement, as it is likely to do us harm, as we were the contractors who supplied them.

The true facts are these. We were informed that the E.M.F. was 100 volts, and we supplied lamps (not of German manufacture) of that pressure, and guaranteed them to run for 1,000 hours. At the end of a fortnight about 28 had broken out of 480. We therefore tested the pressure, and found that, instead of 100 volts, it was 106 to 107. It is, of course, hardly to be expected that lamps would stand such overrunning. The committee have now decided to instal German lamps of the proper voltage, and in the meantime we have to suffer for other people's mistakes.

We are, however, so confident of the quality of the lamp that we have written the committee asking them, in common fairness, to allow us to fix up, say, 12 of our lamps at 106 volts in competition with the lamp selected, so as to prove to them that the breakage was through excess of pressure.—Yours, etc., GRAHAM AND BIDDLE.

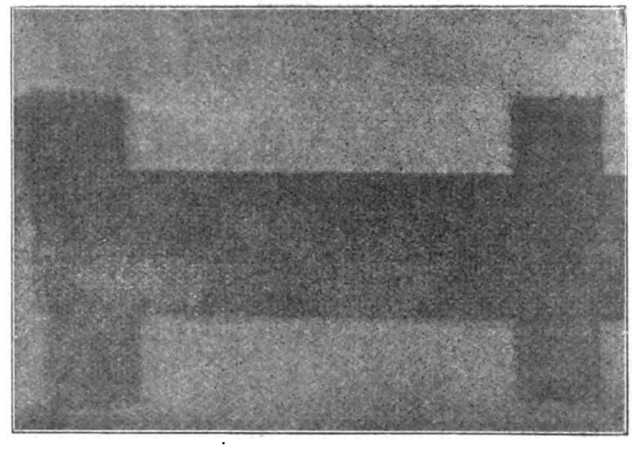
461 and 463, Oxford-street, W., March 3, 1896.

THE NEW RAYS.

SIR,—The following experiment, which was made on February 11 (a brief account of which appeared in the *Daily Telegraph* on February 20), appears to determine that the cause of the phenomena which Prof. Röntgen was the first to discover is the direct result of electric stress, and not, as was supposed, of invisible light.

A No. 14 B.W.G. cotton-covered copper wire was bent five times upon itself in parallel lines. It was then fastened to a piece of cardboard by stitching it at each bend and midway between the bends. A very thin magnetic strip was then placed across the back of a photographic plate, its position being maintained by small pieces of postage-stamp paper. The photographic plate, with the magnet at its back, and the cardboard with the wire attached as described, were next very carefully wrapped up in ruby paper, which was again covered with black paper, the wire on the surface of the cardboard resting on the sensitive surface of the photographic paper—*i.e.*, nothing intervened but the cotton with which the wire was covered. It should also be stated that previous to enfolding the apparatus in the paper, the terminals of the wires were bent back upon the outer surface of the cardboard, and that the whole process was conducted by a photographer in his dark-room. The terminals of the wires were then connected with the wires of a Fowler's alternator dynamo giving 40 periodicities per second, and a current of about eight amperes was sent through the wire for about 47 minutes.

After the development of the results by the photographer on the following day examination showed not only the complete image of the magnetic strip, but of the stamp paper also by which it was affixed to the glass, together with a representation of the red line which exists near one edge of the paper and the segments of the perforations where the stamps had been torn away. It is particularly worthy of notice that these effects were the product of stress in the wire exercised through the glass plate upon the magnet and the paper. It is perhaps well to add that I have obtained similar results upon two other occasions, when the method of conducting the experiments under electromagnetic stress and with the total exclusion of light was upon somewhat different lines. I am sending a photographic copy of the first stress image which I obtained by the process described above. The magnetic strip is seen in the centre, and the two pieces of stamp paper crossing the ends of the magnetic strip.



I may, perhaps, be permitted to explain the very simple process by which, as it appears to me, all photographs are taken, and also the intimate connection which exists between photography and those stress images, or pictures, which are capable of being obtained by the Röntgen rays, or by the stress of magnetism, electromagnetism, or any stress-propagating body. It is well known that all forms of matter are polar—*i.e.*, they assume a definite direction when they are free to move in a magnetic field. As a matter of fact, owing to terrestrial magnetism, all matter exists in a magnetic atmosphere—*i.e.*, every molecule of matter is a stress-creating body—and from such cause takes a special direction when free to move and it is acted upon by other matter. Light is one of the disturbing elements, and therefore when it falls upon the sensitive surface of a photographic plate, the molecules are thrown into motion. Now, as the matter in question may be said to have one general uniform material condition, it is obvious that the general effects upon the surface would be the same, provided the light impinged equally upon all portions of it, but that when it is *reflected* from any image, the counterpart of that image would be produced upon the plate, because the impressions and the molecular motion would vary with the character of the image.

Passing now to the images or pictures, etc., which are obtained by the stress of magnetism, electromagnetism, or

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possibly of almost any other mode in which stress is capable of being propagated, the same principle holds good, for the sensitive matter upon the surface of a photographic plate registers the various directions in which impressions have been conveyed directly or indirectly to it and through *intermedial* bodies. Thus if the stress be the effect of a Röntgen tube, or of any other similar medium, any object which intercepts or otherwise deals with the lines of stress modifies proportionately the effects made upon the plate, and therefore it is that the images laid down upon the plate are correct representations of the bodies which in proportion to their density have interfered with the lines of stress. A cause is thus found for the disappearance of the flesh of the fingers, etc., as is known to occur when the stress has been so increased as to render these tissues quite transparent, whilst those of greater density remain. Upon this principle, also, we recognise the cause of aluminium, one of the lightest of metals, transmitting the rays (stress), whilst iron, lead, and other bodies of considerable density are rendered very apparent.

I may further add that I take a special interest in this subject owing to the intimate connection which exists between it and a theory which I published in the *Electrical Engineer* in 1894 as to the nature and cause of gravity, together with the theory which I have long advocated as to the nature of the process by which animal life is carried on.—Yours, etc.,

RICHD. C. SHETTLE.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

March 6, 2.30 p.m.—Students' visit to inspect the St. Pancras refuse-destructor works. (Assemble at the Works, Georgiana-street, Great College-street, within two minutes' walk of the Camden Town Station, North London Railway.)

March 10, 8 p.m.—At Great George-street, Westminster. Ordinary meeting. Discussion of paper "On Littoral Drift in Relation to River Outfalls and to Harbour Entrances," by William Henry Wheeler (member). And, time permitting, papers to be read: "The Lixiviation of Silver Ores," by J. H. Clemes (associate); "Mining and Treatment of Copper Ore at Tharsis, Spain," by C. F. Courtenay (member); "Tin Smelting at Pulo Brani, Singapore," by John McKillop and T. Flower-Ellis.

March 13, 8 p.m.—Great George-street. Students' meeting. "Tests of Centrifugal Pumps," by J. C. Cornock (student).

Institution of Electrical Engineers.

March 6, 8 p.m.—At the Library of the Institution, 28, Victoria-street. Paper on "A Simple Method of Analysing Harmonic Curves," by E. Basil Wedmore (student).

March 12, 8 p.m.—At the Institution of Civil Engineers, 25, Great George-street, Westminster. Discussion on Mr. G. L. Addenbrooke's paper on "High-Voltage Lamps and their Influence on Central-Station Practice."

March 13, 8 p.m.—At the Library, 28, Victoria-street. Students' meeting (extra) Discussion on Mr. Fennell's paper on "Central-Station Experiences."

March 14.—Visit of Students to Messrs Siemens's Works at Charlton. Train leave Charing Cross at 10.20.

Northern Society of Electrical Engineers.

March 9, 8 p.m.—At the Palatine Hotel, Hunt's Bank, Manchester. Discussion on the paper on "The Parallelling of Alternators," by Robert Hammond.

Society of Arts.

March 10, 8 p.m.—At John-street, Adelphi. "English Book Illustration, 1860-70," by Joseph Pennell.

March 11, 8 p.m.—"Peasant Life and Industries in Ireland," by Prof. A. C. Haddon.

Physical Society.

March 13.—At Burlington House. Papers: (1) "An Addition to the Wheatstone Bridge for the Determination of Low Resistances," by Mr. J. H. Reeves; (2) "On Kathode Rays," by Herr Puluj.

Institution of Junior Engineers.

March 6, 8 p.m.—At Westminster Palace Hotel. "Coal-Conveying Machinery," by C. H. Fletcher (member).

King's College Engineering Society.

March 6, 4 p.m.—At King's College, London. "Aluminium Extraction," by Mr. Hackman.

March 13.—Lantern slides.

Royal Institution of Great Britain.

March 6, 9 p.m.—Mr. A. R. Binnie on "The Tunnel Under the Thames."

March 7, 3 p.m.—At Albemarle-street, Piccadilly. "Light," by Lord Rayleigh, F.R.S. (third lecture).

HIGH-VOLTAGE LAMPS, AND THEIR INFLUENCE ON CENTRAL-STATION PRACTICE.*

BY G. L. ADDENBROOKE, MEMBER.

In the spring of 1891, which was the last occasion when the alternating *v.* continuous current controversy came prominently before this Institution, and when Mr. Crompton brought forward his feeder argument, I had the honour of opening the discussion, and subsequently continued the argument in the technical Press, besides going into it privately with Mr. Crompton. I was not, however, convinced of the superiority of low-pressure direct supply, and on the old premises I remain unconvinced still; but I saw that the advantages of the two systems were in many cases very nearly balanced, and if one or other was ultimately to prevail it would probably be for some other reason than lay in the arguments which had so far been brought prominently forward on either side. It was, in my mind, useless to say that the two systems were each the best for certain situations, for how was the line to be drawn; or in some cases were we to have both systems in one town? Though a possible, this did not seem to me a desirable solution. The question is not merely an academic one. Hundreds of thousands of pounds are every year now spent on electric lighting, and that a large portion of this sum should be spent in a way that is not the best and most permanent is a serious matter. Besides this, as a consulting engineer, I found my position an unpleasant one. What was I to recommend to my clients; and if I halted between two opinions, what would my clients think of me? I regret that in these matters I have not the assurance of some gentlemen who, I understand, circularise all town councils, keep their own touts, and are prepared to give cut and dried verdicts without hesitation on engineering points which, I must confess, I approach with a certain amount of awe and misgiving, and a very serious sense of responsibility. Now, it struck me four years ago, as I daresay it did others, that as the two methods had been argued over so carefully without any definite conclusion being arrived at, probably some outside and fortuitous circumstance which neither side had taken account of would ultimately turn the balance one way or the other.

POSSIBLE SOURCES OF INFLUENCE ON CENTRAL-STATION PRACTICE.

I therefore made a careful survey of the field, and the only eventualities I could think of, or which seemed likely to have a very important bearing on the problem, were the following—viz., the introduction of (1) an altogether new form of lamp, (2) a cheaper material for mains than copper, (3) a high-voltage incandescent lamp, (4) a much more economical incandescent lamp of the present voltage, (5) an improved and much cheaper storage battery.

Respecting a new form of lamp: after having seen Tesla's experiments at the Royal Institution, and after having learnt privately the views of some of our leading investigators on the field which they opened, I must say, as a practical man, I did not see any immediate hope of commercial success in this direction, however interesting the results might be scientifically. As regards the chance of a cheaper conductor being forthcoming, I have dealt with this question at length in a recent article in the *Electrical Review*. Owing to the cheap rate at which aluminium can be produced, and will increasingly be produced in the future, and since the conductivity of aluminium is 56 per cent. that of pure copper of the same section, the chances of aluminium ultimately supplanting copper are strong, but the change will undoubtedly be a comparatively slow one. The possibility of this, however, points to a reduction in the price of conductors; and this, of course, would tell somewhat in favour of moderate pressures. Again, as even in moderate-pressure mains insulated with bitumen or other compounds the cost of insulating is twice the cost of the conductor itself in the sizes usually employed, it it quite conceivable that very important economies may be effected in this direction. It is obvious that improvements of this character would probably tell more in favour of moderate pressure than of high.

Having thus disposed of the conductor question, we come to the third and fourth alternatives I have mentioned as likely to influence central-station practice—viz., the introduction of a lamp of higher voltage, or a more economical lamp of the present current-voltage. When thinking over the matter in 1891, I saw that, as fairly good lamps of 8 c.p. for 100-volt and 110-volt circuits were being made, two of them could be put in series, and that we should get very simply a 16-c.p. lamp of 200 to 220 volts. This, however, involved giving up eight-candle lamps except two in series, which, as the charge for current was then usually 8d. per unit, was a serious matter, and again, as there were two filaments in each lamp, the breaking of either of which would spoil the lamp, this also introduced an important objection, particularly as the Ediswan monopoly maintained the price of lamps at 3s. 6d. for ordinary

* Paper read before the Institution of Electrical Engineers, February 27.

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voltages, and could hardly be expected to supply lamps which would be more expensive to make, except at an enhanced price. The prospect of obtaining high-voltage lamps did not, therefore, at that time appear bright. Time has, however, brought about great changes in the lamp industry, due largely to the expiry of patents, which quickly led to numbers of good lamps being placed on the market at less than one-third the price formerly charged, and at the same time brought active and pushing competitors into the field. Two years and a half ago, finding some disposition abroad to adopt higher voltages, I drafted an article pointing out the enormous gain which would accrue in the distributing system if higher-voltage lamps were adopted, intending to send it to one of the journals. The question, however, then appeared somewhat problematical, and other business led to the article being put on one side. I did not, however, forget the matter, and last December year, finding that one or two firms were trying to introduce lamps of 200 volts, I looked over my draft again, and, having somewhat elaborated it, sent it to the *Electrical Review*. The article attracted the attention of Mr. Baynes, then of Bradford, and he wrote detailing his experience and the experiments he had made with high voltage. Since then the matter has advanced by leaps and bounds. Several lamp-makers are undertaking to supply 16-c.p. lamps of voltages up to 230 and even above; and not only this, but Mr. Stearn and one or two other makers are offering lamps up to this voltage of 8 c.p. also, and guaranteeing a fair economy. The lamps are also being offered at moderate prices. Low-tension central-station engineers have not been slow to perceive the facilities these lamps offer. In some cases they have been adopted publicly, and in other cases private experiments are being made on them with satisfactory results. I also hear from those manufacturers who are catering for the market that the demand for high-voltage lamps is steadily and rapidly increasing. The adoption of these lamps is, of course, somewhat in the tentative stage; but so much progress has been made, and the results attained so far are so good, that no one can doubt that in a year or two they will become a permanent institution. It may also be noted here that since this paper was sent in I see that Prof. Kennedy has considered the 230-volt lamp sufficiently sound to recommend the Town Council of Edinburgh to adopt it.

Concurrently with this development there has been a tendency towards the use of lamps of ordinary voltage but of higher efficiency, and I must say that until recently I have been unable to quite make up my mind which was the best of the two lines to work on—whether it would be better to use lamps of 100 voltage, and taking 2½ watts per candle-power, or lamps taking four watts per candle-power, with a voltage of 200 or 220. I think, however, the matter now admits of being argued out pretty clearly. By a reduction of current per candle-power, in the proportion of 2½ to 4, mains of a given capacity would do nearly double the amount of lighting with the same expenditure of energy. Energy in itself is very cheap, however, and any fair-sized central station could supply double the quantity of energy it is now doing at 1½d. per unit for the extra current, if this did not entail extra expense for extra mains. Now, by doubling the voltage, we reduce the size of the mains to one-fourth, other things being equal; consequently the mains for a station using 220-volt lamps consuming 64 to 70 watts per 16-c.p. lamp, to give the same percentage loss, would not be much more than half the size they would be if the station supplied 110-volt lamps consuming 2½ watts per candle-power, as the current would be nearly the same in both cases. As the cost of mains is such a very large proportion of the whole central-station cost, and as energy can be generated so cheaply, I am fairly confident that, even if a good 2½-watt lamp were obtainable, it would pay better to use 220-volt lamps taking nearly double the current. Conversations with lampmakers, and recent publications on the subject, have convinced me that a good 2½-watt lamp of 100 volts has yet to be attained, and will probably be a very difficult thing to achieve, unless absolutely even pressures in the mains can be guaranteed. The opinion of lampmakers appears universally to be that a 220-volt lamp at 3½ to 4 watts per candle-power is a more practicable and attainable object than a 100-volt lamp at 2½ watts. They seem also unanimous that if a good 2½-watt 100-volt lamp could be made, a good lamp of 220 volts, and of better efficiency than four watts, would be forthcoming. It therefore appears that by taking a 220-volt lamp now we shall get all the advantages of high voltage, and in time shall get nearly as efficient a lamp as if a lower voltage were used, while the high-efficiency lamp is even now in a far less forward state of development than the high-voltage lamp. Consequently, it seems clear that the high-voltage lamp is the better line of the two at present. Besides this, we are anxious to cheapen the cost of current so that it may also be available for power purposes, and thus small economies in consumption will be of less and less moment. It is, therefore, obvious that not only in the present, but for the future, the high-voltage lamp is likely to be the better, and that it is safe to run the risk of being unable to use very economical lamps, provided decent ones of high voltage can be obtained.

As I thought it would give a practical basis to this paper, and would be of interest to members to see specimens of some of the various high-voltage lamps which are being made, I have written to leading makers on the subject, and through their kindness am able to submit a number of 220-volt lamps, concerning which I will now give the particulars supplied by the makers. Lamps to be arranged to burn; present data from makers, etc.: I shall not pursue this branch of my subject further, as it would be more suitably dealt with by a lamp manufacturer in a special paper; but I think enough has been said, coupled with the knowledge members already have of the subject, to show that high-voltage lamps are thoroughly practical for central-station work, and I therefore pass on to consider how far it is desirable to use them, and what effects they are likely to have on central-station practice—this being more immediately the subject of my paper.

Life of High-Voltage Lamps.

We can, of course, hardly expect the life of these high-voltage lamps to be as long as that of lamps of half the voltage, while at the same time they will be rather more expensive, consequently there will be a greater expenditure for lamp renewals when they are used; and it is advisable, I think, to try and arrive at a figure for this before proceeding further. If the life of an ordinary 16-c.p. lamp of 100 volts is 1,200 hours, and it consumes 64 watts, during its life it will consume 77 B.T. units, which, at 6d. per unit, amounts to 38s. 6d. If the cost of the lamp is 1s. 3d., its cost per unit of current consumed is 0·2d., or 1·5d., or about 3 per cent. of the cost of the current. For an eight-candle lamp of 100 volts, lasting 800 hours and taking 36 watts, the consumption of current is 29 units; and at the same price for lamps, the lamp cost per unit of current consumed is about 0·5d., or ½d., or about 8 per cent. of the cost of the current. I have assumed the above life for these lamps because I think, after burning the number of hours indicated above, most lamps would be best thrown away; though I am perfectly aware lamps often last twice as long as I have assumed, and they can also be purchased for 20 per cent. less from reliable makers. Two hundred-volt or 220-volt lamps will, of course, cost rather more, and their life would be rather less, but I believe I am putting the case more adversely for the higher-voltage lamps than is really true in taking the cost as double the above rates for lamp renewals where high-voltage lamps are used. The cost of lamp renewals would then be 6 per cent. of a customer's bill if the current was 6d. per unit for 16-c.p. lamps, and 16 per cent if 8-c.p. lamps were used. Supposing the number of 16-c.p. lamps installed to eight-candle lamps is about as 1 : 2—which is, I think, about a fair average—an all-round reduction of 6 per cent. in the charge per unit of current would cover the additional cost of lamps, if lamps of high voltage were used; at 6d. per unit for current, this is about one-third of a penny per B.T. unit. Such figures as these can only be approximate, but I think you will agree that they would not be far out in practice, and may be improved upon, and also that they make it clearly manifest that the extra cost of using high-voltage lamps offers no appreciable bar to their introduction, providing that their other countervailing advantages are in excess, with which branch of the subject I will now deal.

(To be continued.)

THE PHYSICAL SOCIETY.

At the ordinary meeting on February 28, Prof. John Perry, vice-president, in the chair,

Sir D. Salomons showed some experiments with incandescent lamps. A large electromagnet is excited by means of a continuous current while an alternating current is passed through an incandescent lamp. On bringing the lamp near the magnet the filament is set in vibration, which, if the lamp is brought sufficiently near the magnet, is sufficiently intense to break the filament. The number and position of the nodes formed in the vibrating filament are found to be independent of the natural period of the filament, but depend on the frequency of the alternating current.

Prof. S. P. Thompson asked whether it was not found that the number of segments into which the filament is divided depended to some extent on the natural period of the filament.

Prof. Ayrton said that the magnetic leakage was very large with the arrangement adopted, and he would like to know whether this method was a more sensitive one for mapping out the field than those ordinarily employed. In an instrument designed by Prof. Perry and himself an alternating current was passed through a wire stretched between the poles of a magnet, and the tension of the wire was altered till the vibrations set up were a maximum. The natural period of the wire, and hence the frequency of the alternating current, was then deduced from the tension, etc. In Prof. Ewing's magnetic curve tracer, on the other hand, the natural period of the stretched wire was made as different as possible from the period of the alternations which were to be observed, so that the natural vibrations of the wire did not

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influence the results. The author's arrangement appeared to him (Prof. Ayrton) to be intermediate between these two, and it would seem that the natural period of the filament would to a certain extent influence the results.

Prof. Perry suggested that the lamp might be held in a very steady support so that after the large vibrations due to the natural period of the filament had died out the vibrations of the period of the alternations alone could be observed.

Sir D. Salomons in his reply, said that the arrangement was not intended for making measurements. A lamp had been fixed in a steady clamp, and the current passed for many hours, but the character of the vibrations remained unaltered He had found the vibrating filament useful for microscope work, where a surface rather than a line of light was required.

Prof. Fleming read a paper by himself and **Mr. Petavel** on **"An Analytical Study of the Alternating-Current Arc."** The first part of the paper consists of an analytical study of the distribution of light throughout the various radiating regions in the arc when supplied with electric power of known constant amount, the periodic variations of the current through the arc and of the potential difference between the carbons being at the same time recorded. The power was measured by means of a bifilar watt-meter, while by means of a series of mirrors and a rotating disc carried by a synchronising alternate-current motor the mean value of the light taken from any part of the arc was compared with the instantaneous value of the light taken from the same part of the arc, and taken at any assigned instant during the period. Thus the arc itself was its own standard, and difficulties due to slow variations in the mean light of the arc disappear. The facts observed may be summed up as follows: The purple light of the true arc undergoes a periodic variation, and, as far as the eye can judge, is completely extinguished during a certain interval during the phase. It has equal maxima values during the period at instants slightly lagging behind the instants of maximum power expenditure in the arc. On the other hand, the illuminative power of the carbon crater varies between a minimum value and two unequal maxima, the greater maximum occurring when the carbon is positive and an instant slightly lagging behind the instant of maximum power expenditure in the arc. The second part of the paper consists of a comparison of the efficiency of the alternate-current arc regarded as a light-giving agent as compared with that of a continuous current arc taking the same mean power. Using two arcs, which may be regarded as typical of those used in practice, the mean spherical candle-power was compared for equal expenditure of power in the arcs, and it was found that for the alternating-current arc employed the total mean spherical candle-power was always less than that of the continuous current arc. Lowering the frequency seems to decrease the efficiency of the alternating-current arc.

Prof. Ayrton said the behaviour of the alternate-current arc was of great interest, for the power supplied could not be measured by simply multiplying the current by the E.M.F., since the current lags behind the volts. The resistance—*i.e.*, the ratio of the current to the E.M.F.—also lags, but the authors do not appear to have made any attempt to measure the true resistance The authors were to be congratulated on the guarded tone they had adopted as to the bearing of these experiments on the question of the relative efficiency of the alternating and continuous current arcs. In a previous communication, one of the authors had stated that the alternating-current arc must necessarily be a less efficient light-producing agent than the continuous-current arc. Although the last set of curves given in the paper might appear to support this supposition, he (Prof. Ayrton) felt that the difference obtained was probably due to the fact that the alternating-current arc was not being worked under proper conditions. The quality of the carbons and the length of the arc have a most important influence on the efficiency of an arc At present our knowledge is not sufficient to allow of our stating definitely whether or not an alternating-current arc can be made as efficient as a direct-current arc, but there is no doubt that it will be possible to get much better results than are at present attainable.

Prof. S. P. Thompson said that when the fact of the existence of the difference in phase between the current and volts in an alternating arc was first published he had made some experiments, which showed that there was a lag and not a lead—*i.e.*, that the arc acted as if it possessed self-induction. The resistance also lagged, and he thought this lag might be due to a thermal lag. The temperature of the arc will lag behind the current, both when it is increasing and when it is decreasing, and if the resistance of the arc depends on the temperature of the vapour in the arc then the resistance would also lag behind the current. It was not possible from *à priori* reasoning to say whether or no an alternating-current arc could ever be obtained of an efficiency equal to that of the direct-current arc. With suitable carbons, length of arc, current, and volts it seemed to him that it might be possible to obtain an equal efficiency. The light-giving process in an arc is not merely an irreversible degradation of electric energy into heat, for the difference of potential between the carbons may be written $V = a + bl$, where a may be regarded as a back E.M.F. and bl as a true resistance The first term of this expression does not vary with the length of the arc, l, but the second term does. Multiplying through by the current, C, the equation, watts expended $= Ca + Cbl$, is obtained. It is the first of the terms on the right-hand side which is a reversible effect, and corresponds to the power expended in driving the current against a back E.M.F. on which the light given out chiefly depends due to something occurring at the crater surface.

Mr. Blakesley asked whether Prof. Thompson's idea of the light being due to the reversible part of the process was not a strong argument in favour of the direct-current arc.

Prof. Ayrton said that in two communications made to the congress held at Chicago it was shown that even with direct-current arcs there was a certain length of arc for which the efficiency was a maximum. Mrs. Ayrton had quite recently found that the efficiency of arc lamp carbons altered with time. Prof. Thompson's suggestion as to a thermal lag was a valuble one.

Prof. Fleming, in his reply, said that when comparing two agents where there were so many variables it was practically necessary to restrict the investigation In their case they had kept the mean power constant and had left the other variables to take care of themselves.

The society then adjourned till March 13.

CITY OF WORCESTER.

The following is an abstract of the Corporation electric light accounts for the year ending December 31, 1895, which have just been published, together with a report by the city electrical engineer:

Dr. Capital Account.	£	s.	.
Lands, including law charges incidental to acquisition	5,182	8	8
Buildings	19,706	16	6
Machinery, Mains, including the cost of laying the mains and services, Transformers motors, etc	25,111	7	3
Meters	1,154	17	6
Electrical instruments, etc.	212	17	2
General stores (cable, mains, lamps)	214	15	2
Preliminary expenses	504	7	3
Advertising, printing, and sundries	138	16	3
	£52,225	15	9
Balance	2,852	4	5
	£55,078	0	2

Cr.	£	s.	d.
Stock issued	53,070	0	0
Premiums thereon	1,858	18	0
	54,928	18	0
Service lines	86	13	1
Sale of boilers and other effects at Powick	56	12	1
Interest allowed by treasurer	5	17	0
	£55,058	0	2

Revenue Account.

Dr. To Generation of Electricity.	£	s.	d
Coal	1,092	5	1
Oil, waste, and engine-room stores	161	3	7
Wages at generating station	997	0	2
Repairs to cottage property, etc.	47	10	6
Repairs to plant	29	0	10
To Distribution of Electricity.			
Wages of linesmen, fitters, and labourers	27	11	6
Repairs, maintenance, and renewals of mains	26	4	4
To Public Lamps.			
Attending and maintenance	228	3	11
To Rents, Rates, and Taxes.			
Rents	18	7	8
Rates and taxes	26	6	11
To Management Expenses.			
Salaries, engineer's department	281	10	8
Stationery and printing	50	7	4
General establishment charges	49	6	8
Law charges	5	16	4
Insurance	16	15	1
	3,057	10	7
Balance carried to net revenue account	196	16	8
	£3,254	7	3

Cr.	£	s.	d.
Sale of current per meter at 1d., 3d., and 5d. per Board of Trade unit, £2 709 11s. 10d.; less discounts, £228. 12s. 9d.	2,480	19	1
Public lighting	565	10	0
Rental of meters and other apparatus on consumers' premises	131	16	7
Testing fees and lamps	1	10	6
Rents	74	6	5
Miscellaneous	0	4	8
	£3,254	7	3

General Balance-Sheet.

Liabilities.	£	s.	d.
Capital account—amount received	55,078	0	2
Sundry creditors	1,014	19	4
Sinking fund account	952	13	4
	£57,045	12	10

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Assets.			
Capital account—amount expended for works	52,225	15	9
Stores on hand December 31, 1895—coal, £40; oils, waste, etc., £22 15s. 2d.	62	15	2
Sundry debtors for current supplied to Dec. 31, 1895	1 143	7	0
Public lamps.....	157	0	8
Other debtors	63	18	3
Cash with treasurer.....	1 949	1	8
Net revenue account—balance, being deficiency on revenue account	1,443	14	4
	£57,045	12	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units.....		348,251
Quantity sold—		
Public lamps.....	33,890	246,912
Private consumers by meter.....	213,022	
Quantity used in works		8,955
Total quantity accounted for.....		255,867
Quantity not accounted for		92,384
Number of public lamps—27 arc lamps of 500 watts each, six incandescent lamps of 112 watts each.		
Total maximum supply demanded (kilowatts)		432·7

REPORT ON THE ELECTRICITY DEPARTMENT'S WORK IN 1895 BY MR. E. T. RUTHVEN-MURRAY.

In order that you may better realise the result of last year's working, I have analysed the return and accounts in such a manner that a comparison may be made between our own figures and those published by other electricity supply stations, and in making these comparisons the charges for interest and sinking fund have been excluded. Taken as a whole, our total costs figure of 2·97d. per unit sold is decidedly satisfactory, although it is higher than I anticipated. Nevertheless, if the average price obtained, 3·163d., were not so extremely low, we should have made a substantial profit. Undoubtedly the figure in the cost which looks out of proportion is that of 1·06d. per unit sold for fuel; and in the reduction of this figure I see most hope of lowering the cost of generation in future. There are several reasons why this figure is so large, and pre-eminent is the fact that the available water power did not come anywhere near its calculated value, with the result that from the end of May until the end of November it was necessary to run a portion of the day on steam only. About Midsummer there was so little water in the Teme that as much as 75 per cent of a total week's running hours were done on steam power. As the engines at the works are all of 286 i.h.p., we had no choice but to run these at the very low load which was the maximum that could be obtained, and at a load-factor so small that high efficiency and low consumption of steam, and therefore of fuel, was impossible. A condenser was thought unnecessary when the works were equipped, but this omission is now made good, and will, I have no doubt, effect an economy in the steam consumption of the engines of upwards of 20 per cent. Before it became necessary to run by steam power in the daytime, we were using Staffordshire coal entirely, but in consequence of repeated complaints about smoke, you instructed me to burn Welsh smokeless coal when found necessary, which, being considerably more expensive, is an important factor in the cost of fuel. The reason for so much coal being used was to keep running for the electric pumping plant at the waterworks. I estimate that not less than 400 tons of coal were used entirely to keep one motor running during the summer. As the price we received from the Water and Sewerage Committee was only 1d. per unit, it will be seen that over the whole year our costs show a higher figure than this for coal alone, and instead of making anything out of the day load found by these motors, you have actually lost money by having them on circuit. During the summer the contractors were engaged in replacing the coils of the alternator armatures with others of improved type, and to test them it was necessary to run the machines for many hours continuously. As no water power was available, steam had to be used, and testing accounts for some 80 tons of coal It is authoritatively stated that the past summer was one of unusual drought; therefore we may not be so short of water during the coming season. We have recently improved the figure for cost of engine-room stores, by alteration of the lubricating arrangements on the machinery at the works Of the figure ·267d. per unit, ·156d. is engine-room stores. The figure of ·111d. for carbons is not a true result of the year's working, as the carbons used during the few months of last year were altogether omitted, and have been added here We are now purchasing carbons at about 22 per cent less than we were during last year, and in the next report the figure of ·267d. per unit will be materially reduced. The next figure of 1·088d. per unit for wages at works is low for the character of the station, and cannot be reduced except in so far as it will be from the larger output we may expect this year. It is apparent that this will fall proportionally as the output rises. The same remark applies to the figure for repairs and maintenance, which I do not anticipate will much increase. The figure which includes legal expenses, management, and insurance may be altered other than proportionally, although the figure for rates, taxes, and rents should share in the reduction from increased output. Turning from costs to revenue, the most striking item is that of the average price obtained, which, excluding revenue derived from meter rents, property rents, etc., only amounts to an average of 2.73d. per unit, a figure without parallel in the annals of the electricity supply business, The figure, including revenue from other sources, 3·16d., is lower than any recorded. The waterworks motors are again mainly responsible for these figures. They were supplied with 103,644 units, for which we received the sum of £431. 17s. This number of units bears the relation of 41·9 per cent. to the total output of 246,912 units. For the remaining 58·1 per cent. (143,268 units) we received £2,386. 8s. 2d., or an average of 3·99d. per unit, a figure above the lowest on record of other stations. Bearing in mind the unusual difficulties we have had to engage with and overcome during the past year, our results cannot but be considered satisfactory. The number of lamps we have taken on is very gratifying, amounting to an increase of over 200 per cent., and I have no doubt, from information received, that we shall have a large accession of small consumers, from whom we derive a much better revenue per lamp than from most of the larger ones during this year.

WATER AND STEAM POWER.—The following table shows the percentage of hours running by water and steam power during the past year:

	January to June.	July to December.	Whole year.
Water alone	85 per cent.	49 per cent.	67 per cent.
Steam alone	10 ,,	40 ,,	25 ,,
Water and steam	5 ,,	11 ,,	8 ,,

BRISTOL CORPORATION ELECTRICITY WORKS.

The accounts have been issued of the working of the electric light station of the Bristol Corporation during the year ended December 31, 1895. The expenditure during the past year reached £15,608. 8s. 5d., and the total expenditure to December 31, 1895, has amounted to £97,794. 11s. 10d. Below are given the revenue account and balance-sheet.

REVENUE ACCOUNT YEAR ENDING DEC. 31, 1895.

Dr. To Generation of Electricity.				£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£1,616	1	9			
Oil, waste, water, and engine room stores	156	9	3			
Wages at generating station.....	1,178	3	0			
Repairs and maintenance as follow: buildings, £12. 18s. 8d.; engines, boilers, etc, £81. 1s. 10d.; dynamos, exciters, etc., £1. 10s. 3d; condensers, other machinery, instruments, and tools, £70. 15s. 8d.; accumulators and accessories, £22. 10s. 1d.	188	16	6			
Removing ashes	35	0	0			
				3,174	10	6
To Distribution of Electricity.						
Wages and other remuneration to linesmen, fitters, labourers	80	4	10			
Repairs, maintenance, and renewals of mains of all classes, including materials and laying same, £58. 8s. 10d.; less amounts chargeable to contractors, £34. 2s 1d.	24	6	9			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of lamps sold, as *per contra* ...	35	1	4			
Repairs maintenance, and renewals of apparatus at distributing stations	51	8	0			
				191	0	11
To Public Lamps.						
Attending and repairs	367	7	0			
Carbons and renewals of lamps	143	14	5			
				511	1	5
To Rents, Rates, and Taxes.						
Rents payable	482	13	0			
Rates and taxes	556	0	0			
				1,038	13	0
To Management Expenses.						
Engineer's department	400	0	0			
Secretary and clerical staff	332	6	10			
Stationery and printing	75	5	9			
General establishment charges.....	130	16	7			
				938	9	2
Law expenses, including stamp duty on mortgages of general district rate				19	1	2
To Special Charges.						
Fire and boiler insurance, employer's liability and fidelity guarantee premiums				53	19	2
Cost of canvassing for new customers				35	19	2
Expenses *re* fatal accident to Robert Coleman				5	8	5
Total expenditure.....				5,968	2	11
Amount carried to net revenue account				4 019	19	10
				£9,988	2	9

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Cr.	£	s.	d.
Sale of current per meter, £6,332. 10s 7d.; less discounts, £226 17s. 11d.	6,105	12	8
Rental of meters on consumers' premises	288	17	7
	6,394	10	3
Less bad debts	6	13	9
	6,387	16	6
Electricity supplied to public lamps, £2,936. 2s. 5d.; and attendance and repairs of public lamps, carbons, etc, as *per contra*, £511. 1s. 5d.	3,447	3	10
Incidents	9	7	8
Premiums received with improvers whose terms have expired, £200; less proportion to engineer for tuition, £90	110	0	0
Sale of incandescent lamps	33	14	9
	£9,988	2	9

GENERAL BALANCE SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	£100,000	0	0
Sundry creditors	852	16	5
Net revenue account—balance at credit thereof	1,786	11	11
Suspense account—balance	269	0	0
Deposits as security	122	0	0
	£103,030	8	4

Assets.	£	s.	d.
Capital account—amount expended for works	97,794	11	10
Stores on hand Dec. 31, 1895—coal £44 4s.; oils, waste, etc., £30. 15s.; general £119 10s. 2d.	194	9	2
Sundry debtors for current supplied to Dec. 31, 1895	4,143	17	9
Other debtors	300	11	0
Cash in hand and at bank	596	18	7
	£103,030	8	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B. T. units		554,711
Quantity sold—		
Public lamps	156 593	408,301
Private consumers by meter	*251,708	
Quantity used on works		20,100
Total quantity accounted for		428,401
Quantity not accounted for		126,310
Number of public lamps		99
Total maximum supply demanded at 2,000 volts (kilowatts)		514 5
Total maximum possible demand (kilowatts)		721 62

* This item covers one-third of the quantity used in the day time which is unable to be ascertained, owing to the description of clock meter used by day-load consumers, as well as the ordinary loss in mains, transformers, instruments, etc.

LEGAL INTELLIGENCE.

CLAIM FOR ELECTRICAL WORK.

At the Westminster County Court on Tuesday, before his Honour Judge Lumley Smith, Q.C., the case of Sabow *v.* Haynes was heard.

The plaintiff's claim was for a balance of account amounting to £10. 16s. 2d. in respect of electrical fittings supplied and fixed to defendant's order. In his evidence, the **Plaintiff** said he carried on business at Fulham, and in the early part of 1895 he got instructions from the defendant to supply and fix a quantity of electrical fittings. The work was completed in July, and a portion of the amount due was paid on account, but for some reason or other the defendant declined to pay the balance, and set up a counterclaim for damages for defective work.

The **Defendant** admitted that there was a balance due to the plaintiff, but he contended that he was not liable on the ground that the work was so badly done as to be absolutely useless.

After hearing the evidence, his **Honour** said he was by no means satisfied with the defendant's story, and gave judgment for the plaintiff on claim and counterclaim.

COMPANIES' MEETINGS AND REPORTS.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

The annual general meeting of this Company was held on Wednesday at the Company's central station, Cadogan-gardens, Mr. J. Irving Courtenay presiding.

The **Chairman**, in moving the adoption of the report and accounts, a copy of which has appeared in this journal, said last July they lowered the charge for current by 25 per cent., and consequently the increase in revenue might not seem so large as might have been expected. They were enabled to recommend the same rate of dividend on the ordinary shares—5 per cent.—as that paid last year, they had placed £1,047 to a reserve fund, and they proposed to carry forward £1,114. They had again reduced the cost of production. They had had a considerable increase—over 10,000—in the number of lamps supplied, and this increase was still going on, and even to a larger extent. The continued expansion of the business created a recurring need for fresh capital, for they only raised additional capital and increased their plant and mains from time to time as wanted. During the past year they had completely altered and equipped the new generating station in Manor-street, and a new storage station for the supply of the Fulham road district would shortly be completed. An injunction had been granted against the Company in respect of the generating station at Cadogan-gardens, but he hoped they would shortly be in a position to deal with this troublesome matter in a manner which would put an end to further litigation. The electric light supply companies carried on a *bonâ fide* and necessary business, and with, as yet, only moderate returns to their shareholders. They had statutory duties to fulfil, and, in his opinion, without adequate legal protection, and they were considered as fair game to be shot at, the alternatives generally presented to them being either to purchase peace at any price which the occupier of an adjoining property chose to demand, or to run the risk of being forced to discontinue the full use of premises upon which a large capital had probably been spent.

Major-General Webber, C B. (deputy chairman), seconded the motion, which was carried unanimously.

HOVE ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Colonel A. J. Filgate, R.E. (chairman); Colonel H. Wood, C B. (vice-chairman); Harold A. Hoare, Esq.; Carleton F. Tufnell, Esq. Engineers: Messrs. Crompton and Co., Limited. Secretary: Francis R. Reeves, Esq.

Fourth report of the directors presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon-street, E.C., on Wednesday, March 4, 1896, at 12 o'clock noon:

The number of lamps attached to the Company's mains has now increased to the equivalent of 18,403 8-c.p. lamps, and the number of consumers to 270. From the accompanying statement of accounts it will be seen that the result of the year's working is a profit of £2 562. 5s. 3d. as compared with £1,243. 0s. 5d. for the preceding 12 months, and it is satisfactory to report that the consumption of electricity per lamp fixed has increased rather than diminished, as compared with the consumption of the preceding year. The revenue from the sale of current has increased from £3,616 19s. 9d. in 1894 to £5,343 6s. 9d. After adding £15. 12s 9d. from last year's accounts, and deducting £1,038 12s. 7d. for interest on loans and debentures, there remains a balance to the credit of net revenue account of £1 539. 5s. 5d. The directors propose to write off the sum of £134. 15s. from the preliminary expenses account, to place £200 to reserve, to declare a dividend at the rate of 4 per cent. per annum on the share capital, payable on April 15 next, and to carry the balance £152. 14s 6d. forward. The amount realised from premiums on shares and on the 4½ per cent. debentures which were issued last year was £460. 10s.; this has also been placed to the reserve fund, which will now show a credit balance of £660. 10s. In accordance with the contract with the Hove Commissioners, the sum of £263. 9s. 2d. has been also placed to a depreciation and maintenance reserve account. Since the date of the last report the directors have placed 1,719 shares and £7,500 of 4½ per cent. debentures. Offers were received for the balance of the 4½ per cent. debentures at the issue price of £103, but the directors considered it advisable to place no more than the £7,500 at that time. The total number of shares issued to date is 6 260, representing £31,300, and the directors now offer the balance of 1,740 shares to the proprietors for subscription at £5. 5s. per £5 share. As the Company has been placed in a sound position, both financially and as a dividend-earning enterprise, the directors have given notice to the holders of the £12,500 of 5 per cent. debentures that they intend to pay off the same on July 1 next, and have offered to them new debentures of the Company at par bearing 4 per cent. interest in exchange. In response to the circular making this announcement, the holders of £7,250 of debentures have agreed to accept the new 4 per cent. debentures, thus leaving £5,250 to be placed, and the directors entertain no doubt of their ability to place these in July next, when the existing debentures are to be paid off. Owing to the proximity to the sphere of this Company's operations of the Brighton Corporation electric supply works, where the management are not under the same obligation as are the directors of a public company to work for substantial returns upon the money invested, and, in consequence, are able to make a low charge for their production, an adverse comparison has been made between the charges made by the Brighton Corporation and by this Company. The Board, desirous of doing everything in their power to meet the wishes of their customers, have adopted, as from January 1 of the present year, the method obtaining in Brighton of charging by the "demand meter" system, which regulates the rebates or discounts allowed to customers in accordance with the actual consumption calculated upon the maximum number of lamps in use at any one time. This arrangement of charging is, they consider, as fair a one as can be devised and the directors hope that as the system offers inducements to consumers the change will result in a considerable increase during the year in the number of lamps fixed, and a corresponding increase in the consumption of current. The directors have pleasure in again congratulating the shareholders upon the position and progress of the Company. The supply of current has been regular and continuous throughout the year, and the machinery, which is maintained in the highest degree of efficiency, has given the greatest satisfaction. In order to meet the increasing demand for electric

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current in Hove, the directors were obliged last year to add a new Crompton-Willans set of 250 h.p., and two new boilers. With these additions to the plant, it is believed that the Company will be able to meet the demands likely to arise for some time to come. Mr. C. F. Tufnell retires from the Board by rotation, but offers himself for re-election. Mr. Robert Payne, F.C.A., auditor of the Company, also offers himself for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1895.

Dr.				£	s.	d.
To Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£709	4	4			
Oil, waste, water, and engine-room stores	190	13	11			
Proportion of salaries of engineers, superintendents, and officers	204	12	0			
Wages and gratuities at generating station	474	5	7			
				1,578	15	10
To Repairs and Maintenance.						
Amount expended	136	10	10			
Balance set aside in accordance with the contract with Hove Commissioners	263	9	2			
				400	0	0
To Rents, Rates and Taxes						
Rents payable	157	11	10			
Rates and taxes	49	18	11			
				207	16	9
To Management Expenses.						
Directors' remuneration	350	0	0			
Salaries	292	12	0			
Stationery and printing	51	17	7			
General establishment charges	142	16	5			
Auditor of Company	10	10	0			
				847	16	0
To Special Charges.						
Insurances				67	2	9
Total expenditure				3,101	5	4
Balance carried to net revenue				2,562	5	3
				£5,663	10	7

Cr.	£	s.	d.
Sale of current per meter (162,428 units)—private consumers, after allowing rebates and providing for bad debts	5,154	12	9
Public lighting	188	14	0
	5,343	6	9
Rental of meters and other apparatus on consumers' premises	301	8	10
Rents receivable, £16. 15s.; and transfer fees, £2	18	15	0
	£5,663	10	7

GENERAL BALANCE-SHEET, DEC. 31, 1895.

Liabilities.	£	s.	d.
Capital account—amount received	30,985	0	0
Debentures issued 5 per cent.	12,500	0	0
Debentures issued 4½ per cent.	7,500	0	0
Loans from bankers secured by deposit of debentures	3,100	0	0
Sundry creditors, due on construction of plant and machinery, fuel, stores, etc., to December 31, 1895	3,711	19	10
Consumers' deposits	103	5	0
Creditors for interest	226	1	3
Reserve fund	460	10	0
Depreciation and maintenance account reserve fund	263	9	2
Net revenue account, balance at credit	1,539	5	5
	£60,389	10	8

Assets.	£	s.	d.
Capital account—amount expended for works	57,472	5	0
Stores on hand Dec. 31, 1895—coal, £50 6s. 9d.; oils, waste, and general stores, £32. 14s. 9d.	83	1	6
Sundry debtors for current supplied, etc., to Dec. 31, 1895	2,563	13	4
Cash at bankers, £220. 6s. 11d.; cash in hand, £50. 3s. 11d.	270	10	10
	£60,389	10	8

W. T. HENLEY'S TELEGRAPH COMPANY, LIMITED.

The annual report has been issued, and shows that a net profit has been made of £21,823. 19s. 5d. After payment of debenture interest, and income tax, and making an allowance for depreciation of plant, machinery, etc., there remains £17,342. 9s. 2d., to which must be added £1,600. 7s. 9d., the final dividend received from the International Cable Company, Limited, and £8,624. 9s. 3d. brought forward from last year, making a total of £27,567. 6s. 2d. From this must be deducted £2,100, the interim dividend of 3 per cent. paid on the ordinary shares on August 1 last, and £1,050, the half year's dividend on the preference shares paid in October, and there remains a balance of £24,417. 6s. 2d. Of this sum the directors have transferred £5 000 to reserve fund, and they propose the payment of the remaining half-year's dividend on the preference shares at the rate of 7 per cent. per annum, and a further dividend of 5 per cent. free of income tax on the ordinary shares (making a total distribution of 8 per cent. for the year, free of income tax, on the ordinary shares). These payments together absorb £11,050, leaving £13,367. 6s. 2d. to be carried forward.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.

Admiral Sir G. H. Richards presided over the ordinary meeting of this Company, held on Tuesday at 38, Old Broad-street, and moved the adoption of the report. He said there had been very little submarine telegraph work done during 1895, but a great portion of that carried out had been executed by the Company. The total dividend for the year was at the rate of 15 per cent. per annum. The Company was never in a sounder financial position than now, while the prospects of work for the coming year were more favourable.

Sir R. G. W. Herbert seconded the motion, and it was carried unanimously.

ISLE OF MAN TRAMWAYS COMPANY.

The annual general meeting of the Isle of Man Tramways and Electric Power Company, Limited, was held at Douglas last Friday, Mr. Alexander Bruce presiding.

The **Chairman**, in moving the adoption of the report and accounts, said that the balance-sheet showed the total takings to be £26 466 and the expenses to be £11,999, leaving an actual profit for the year of £14,467, which placed them in a unique position compared with any similar undertaking in the kingdom With the balance from last year, the sum available was £15,789. Debenture interest at 6 per cent. and a half-yearly dividend at the rate of 7½ per cent. was paid in June, leaving £10,227 to be dealt with by the meeting. Out of this the directors proposed to add £2,000 to the renewal and reserve fund, had paid £1,299 on debenture bonds, and proposed to pay a dividend at the rate of 6 per cent on the preference shares and on the ordinary stock at the rate of 8½ per cent., absorbing £4,687, making the dividend for the year 8 per cent. on the ordinary stock, and leaving £2,240 to be carried forward.

The report and accounts were unanimously adopted, and Dr. Farrell and Mr. Pittar were re elected directors.

After the general meeting, an extraordinary meeting was held, and a resolution was adopted to take over Snaefell Mountain Electric Railway at £72,500.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Aberdeen.—The Corporation invite tenders for an additional engine of 300 h.p. at the electric lighting station.

Erfurt.—Tenders are wanted by March 11 for the supply of 52,000 carbons for arc lamps for the Prussian State Railways at Erfurt.

Naples.—Tenders are wanted by March 9 for 3,500 kilogrammes of copper wire. The estimate is 6,475 lire. Address, La Fonderia reale, Napoli.

Lima (Peru).—Tenders for the electric lighting of the city of Lima will be received up to June 1 next at the Peruvian Legation, Avenue Hoche 8, Paris.

Namur.—Tenders will be received on July 10 next for the construction of a telephone building at Namur. Plans and particulars can be obtained from le Service Téléphonique, Namur.

Duisburg (Germany).—The Municipality require tenders before March 23 for the electric lighting work for their new swimming-bath. Particulars can be obtained for 2 marks (2s.) from the Stadtbaurath, Duisburg.

Zamora (Spain).—The electric lighting of the town of Zamora for 20 years is offered for tender. Conditions are obtainable at the Ministero de la Gobernacion, Madrid, and la Casa consistorial, Zamora. A security of 4,000 pesetas (£160) will be required.

Brunn (Austria).—The Municipality desire offers for the construction and working of a central station for the supply of electric energy for lighting the town, for power, and, if required, for running a tramway. Tenders must be sent before March 31 to the Bürgermeister, Brünn, Austria, from whom particulars can be obtained.

Lisbon.—Tenders are wanted by the Royal Portuguese Railway Company for the supply of apparatus for electric alarm bells. Tenders, suitably endorsed, must be sent to the Chief Engineer, at the Company's Stores, Santa Apolonia, Lisbon, by March 11, and particulars, etc., can be obtained from the Paris Offices of the Company, at 28, Rue de Châteaudun.

Christiania.—Tenders are wanted for the supply of telegraphic instruments, including 26 Morse apparatus, 11 galvanometers, and three signal bells, paper tape, etc., for the Norwegian State Railways. Tenders must be sent in by March 11 to the office, Iernbanctorvet 8-9, and particulars can be obtained of the Inspector of Telegraphs, Ostbahnstation, Christiania.

Pontefract.—The Guardians invite tenders for fitting up the new infirmary with electric bells. Full particulars may be obtained on application at the offices of Messrs. J. Holmes Greaves, and Co., architects, 38, Albion-street, Leeds; Corn Market, Pontefract. Sealed tenders, on proper forms, to be delivered at the Union Offices, Pontefract, by 6th inst., at 4 p.m., endorsed "Elec ric."

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Bucharest.—The authorities of the city of Bucharest require tenders for some system of lighting the suburbs which does "not require to be conveyed underground by pipes or otherwise." Particulars can be obtained at the Agence Havas, 96, Queen-street, Cheapside, E.C., and tenders will be required by March 26.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grange-town, Yorkshire, to whom the plans, etc., must be sent by May 1.

Glasgow.—Tenders are required by the Corporation for a compound dynamo machine for the sewage purification works, Dalmarnock. Specifications and forms of tender may be had on application to Mr. Thomas Melvin, manager at the works, and tenders, properly sealed, and marked outside "Tender for Dynamo Machine," must be lodged with Mr. J. Lang, clerk, City Chambers, Glasgow, by 14th inst.

London, S.W.—The Guardians of Chelsea invite tenders for the supply and fixing of telephones and communications with certain wards and rooms of their infirmary in Cale street, in accordance with a specification which may be obtained, and samples of the instruments and fittings which may be seen, at their offices, 250, King's-road, Chelsea. Tenders must be delivered at the Guardians' offices by noon on March 10.

Paris.—The Direction générale des postes et des télégraphes, rue de Grenelle 103, Paris, require tenders for the supply of 10-millimetre and 16 millimetre paper tape for telegraphic instruments. Application for permission to tender must be made to the Direction by March 14, and tenders sent in by March 24. Tenders are also wanted for nine lots of apparatus for telegraphic offices. In this case application must be made by March 15, and tenders sent by March 25.

Leeds.—The Electric Light Company invite tenders for the various works required in the extension of the electric light station in Aire street, Leeds. Plans and specifications at the offices of the company, Aire-street, and bills of quantities on application to Messrs. Milnes and France, architects, 99, Swan-arcade, Bradford, on 12th inst. and until 19th inst., on which latter day sealed tenders, properly endorsed, are to be delivered to the architects by 6 p.m.

Herne (Germany).—It is proposed to make a street railway nine kilometres (5½ miles) long from Herne to Recklinghausen, to be worked either by gas motors or electric traction. The undertaking will be put out to general competition, and the contractor will have to covenant for its completion in from one to five years. Tenders must be sent in by March 18, and particulars price 1 mark (1s.), can be obtained from Herr Amtmann Schaefer, Der Verwaltungsausschuss Herne.

Manchester.—The Manchester, Sheffield, and Lincolnshire Railway Company invite tenders for the supply, during twelve months ending April 30, 1897, of telegraph materials. Patterns can be seen on and after March 9, on application to Mr. A. W. Longden, storekeeper, at Junction-street Mills, off Ducie-street, London-road, Manchester; and specifications, with forms of tender, may be obtained on and after same date, from Mr. Oliver S. Holt, secretary, London-road Station, Manchester. Applicants are requested to particularise the stores for which they wish to tender. Sealed tenders, endorsed "Tender for ——," to be in the hands of the secretary by 10 a.m. on March 17.

Chesterton (Cambs).—The Urban District Council is open to receive tenders for the public lighting of the district for seven years. The tenders shall be made in the three following modes—namely, (*a*) lighting the district from August 14 to May 15 (inclusive) in each year; (*b*) lighting the district throughout the whole year commencing May 15 next; (*c*) lighting the district for either of the above periods (1) with ordinary burners, (2) with incandescent burners, if the illuminant with which the tender be made be gas. All cleaning, lighting, and maintenance to be done by the contractors. Tenders to be sent to Mr. James Spearing, clerk, 15, Sydney-street, Cambridge, by March 31.

Sunderland.—The Corporation want tenders for the following plant required at the electric supply station: (*a*) two steam-engines and continuous-current dynamos, with steam and exhaust pipes and switchboard extensions; (*b*) two water-tube boilers of Babcock and Wilcox type; (*c*) fuel economiser; (*d*) a water-softening plant; (*e*) a cast-iron tank. Specifications, general conditions, and form of tender can be had at the office of the borough electrical engineer, electric supply station, Sunderland, on payment of a deposit of £1. 1s. for each of the above. The deposit will be refunded on the receipt of a bona fide tender. The tenders will be let subject to the consent of the Local Government Board to the application of the borough of Sunderland for the extended loan for the above works. Tenders to be delivered at the office of Mr. Fras. M. Bowey, town clerk, Town Hall, Sunderland, by 5 p.m. on March 13, addressed to the Chairman of the Highways Committee, and endorsed "Tender for Extension of Electric Supply Station."

Bangor.—The Corporation invite tenders for the construction, supply, and laying down of the necessary plant and mains for the supply of electricity in the borough. The contract will be split up into two sections: (1) construction, supply, and erection of boilers (water-tube), steam-engines (double acting), steam and exhaust pipes, etc., economiser, feed pumps, condenser, alternators, exciters, accumulators, switchboard, travelling crane; (2) supply and laying down of mains and transformers. Specifications and plans may be obtained on payment of £2, 2s. for the former and £1. 1s. for the latter, which will not be returned, at the office of Mr. F. Hastings Medhurst, M.I.E E., Westminster-chambers, 13, Victoria-street, S.W., on and after 24th inst. The firm whose tender is accepted will be required to enter into a contract and a bond with two approved sureties for the due performance of the contract. Firms may tender for one or both sections, but tenders for a part only of either section will not receive consideration. Sealed tenders, endorsed "Electricity," to be delivered at the office of Mr. W. H. Pritchard, town clerk, Bangor, by March 18.

RESULTS OF TENDERS.

Alexandria.—The concession for the electric tramways at Alexandria has been awarded to Mr. P. Cauderay, Paris, on the basis of an annual payment of £58 per tramcar run.

Blackpool.—The Corporation have accepted the tender of Messrs. John Fraser and Son, of the Millwall Boiler Works, London, for the supply of two boilers, and all fittings included in Section A of the specification, and also the whole of Section C of the specification for evaporative condensers. The tender of Messrs. S. Z. de Ferranti, of London, for the supply of one 300-kilowatt alternator and two rectifiers, and the tender of Messrs. Tinkers, of Hyde, for the supply of pipe work, were also accepted.

BUSINESS NOTES.

Manchester.—The Tivoli (Folly Theatre) is to be redecorated and lighted with electricity.

Cardiff.—The Lighting Committee have agreed to contribute to the cost of lighting the arcade.

Western and Brazilian Telegraph Company.—The traffic receipts for the past week were £2,624.

Brompton.—The whole of the buildings at the Hospital for Consumption have been lighted by electricity.

Wells (Somerset).—The Town Council are about to apply for sanction for a loan of £10,000 for electric lighting.

Plymouth.—The Chamber of Commerce has held a meeting in support of telegraphic communication with lighthouses.

Leeds.—It is proposed to erect two new arcades in New Briggate, which will be completely fitted with the electric light.

Faversham.—The electric light station at the works of the Cotton Powder Works Company, Limited, has been destroyed by fire.

Eastern Telegraph Company.—The receipts for the month of February were £69,711, as against £62,342 for the corresponding period of 1895.

Kilmarnock.—A party of Messrs. Grant, Ritchie, and Co.'s men have visited the Ballochmyle Quarries and inspected the electric lighting there.

Bridlington.—The electrical engineer to the Urban Council has been instructed to have the Prince's-parade lighted by electricity during the Easter holidays.

Bangor (N. Wales).—The Town Council have confirmed the action of their committee in advertising for tenders in connection with the electric lighting scheme.

Salford.—The Town Council have decided to apply for the sanction of the Local Government Board to borrow £5,000 for requirements as to electric lighting.

Eastern Extension Telegraph Company.—For the month of February the receipts show an increase of £14,050 as compared with the corresponding period of 1895.

Swansea.—The Streets Committee of the Corporation have instructed the borough surveyor (Mr. Bell) to inspect the Swansea tramway lines and report on their condition.

West India and Panama Telegraph Company.—For the two weeks ended February 29 the receipts were £2,681, as against £1,947 for the corresponding period of 1895.

Portsmouth.—The estimate for the next rate shows an advance of some £3,500, one of the principal items being the cost of extending the street-lighting by electricity.

Halifax.—The Gasworks Committee of the Corporation have decided to recommend the Town Council to apply for sanction to borrow £20,000 for electric lighting purposes.

Salford.—The Gas Committee recommend the Borough Council to apply to the Local Government Board for sanction to borrow £5,000 for requirements as to electric lighting.

Aberdeen.—In view of the increased demand for the supply of electric current, it has been remitted to the electrical engineer to report as to an extension of the works and mains.

Worcester.—The Town Council have decided to lay mains in Bridge street, College-street, The Tything, and the road to Shrub Hill, for further electric lighting, at a cost of £1,000.

Newcastle-under-Lyme.—The Town Council have refused their consent to a deviation of the tramway from Stoke, and have decided to oppose the Bill for tramway extension to Newcastle.

Woolwich.—The Local Board of Health have agreed to the closing of Victoria-street, on the condition that Messrs. Henley's Telegraph Company provide a parish wharf 149ft. long and 40ft. wide.

St. Giles's (London).—The new public library just opened in New Oxford-street is lighted throughout by electricity, the fittings and installation being supplied by Messrs. Pontifex and Co., of Coleman-street.

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Aluminium.—We have received from the Pittsburgh Reduction Company a copy of their treatise on aluminium. The book is published by the European agents of the company at 38, Victoria-buildings, Manchester.

Belfast.—The Corporation have received a deputation on the unsatisfactory state of the tramway service. In the course of the proceedings it was suggested that some form of mechanical traction might be adopted.

Brazilian Submarine Telegraph Company, Limited. — The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum free of income tax, for the quarter ending December 31.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending March 1 amounted to £1,056, as compared with £934 in the corresponding week of the previous year, being an increase of £122

Tunbridge Wells.—An article by Mr. H. Boot, borough electrical engineer, has appeared in the *Kent and Sussex Chronicle* advocating the adoption of electric tramways by corporations possessing electric light stations.

Northwich.—The Northwich Electric Supply Company, Limited, was registered on February 24, with a capital of £10,000 in £5 shares, to carry on the business of electric lighting at Northwich, Leftwich, Davenham, and Hartford.

Liverpool Electric Supply (Transfer) Bill.—Under this Bill it is proposed that the borrowing powers be increased to £500,000, so as to provide capital for extensions. The town clerk has been instructed to assist the progress of the Bill.

Rose and Bird, Limited.—We are informed that Mr. A. H. Rose has joined this firm in the capacity of managing director, in place of the late Mr. J. A. Bird. The offices of the firm are now at Albany-buildings, 39, Victoria-street, S.W.

St. George's, Southwark (London).—The Vestry have decided to petition against the City and South London Railway Bill so as to obtain a *locus standi* in objecting to any of the shafts which the company propose to sink in the parish.

Derby.—In view of the approaching legislation on the subject of light railways, the committee in charge of the scheme for constructing an electric tramway between Derby and Ashbourne have decided to postpone further action for the present.

Cheltenham.—The Town Council have decided to apply for sanction to borrow £15,000 for electric light extensions. In reply to Major Cardew's report on the recent accident, the town clerk had written that the suggestions made had been carried out.

Bell's Asbestos.—The directors of Bell's Asbestos Company, Limited, have decided to recommend the payment of a dividend at the rate of 3 per cent. per annum, and the placing of £1,000 to the reserve fund, leaving about £2,200 to be carried forward.

Coolgardie (W. Australia).—The Westralian Electric Lighting and Supply Company have secured a monopoly for 21 years from the Municipality of Coolgardie. The company will also supply electric power to the various mines, and the town installation is almost completed.

Blackpool.—The Town Council have approved the proceedings of the Electric Lighting Committee recommending the application to the Local Government Board for further borrowing powers of £30,000 for new boilers and alternators and extensions to the electricity works.

Johannesburg.—It is stated that preliminary negotiations have been concluded for the establishment of an organisation in Johannesburg representing a number of large German manufacturers. The firms co-operating include the Union Electricity Company of Berlin.

Eastbourne.—At the meeting of the Town Council, Councillor Wright called attention to the cost of electric lighting, and asked how much per unit was paid to the company by the Corporation. Alderman Pocock believed it was 8d. per unit, but the Front was lighted under contract.

Bray (Ireland).—At a meeting of the Township Commissioners Mr. Harris, resident electrical engineer, forwarded a report on the machinery necessary to make the electric lighting station perfect; and Mr. Hammond, C.E., was appointed to make out estimates for the necessary repairs to the works.

City of London.—At the meeting of the Commissioners of Sewers Mr. Gordon asked when the experiments in the lighting of the side streets by electricity would be commenced, and Mr. Voysey, the electrical inspector, said it depended upon the City of London Electric Lighting Company. The apparatus was complete, and the experiments would be commenced in about six weeks.

Brighton.—In honour of the visit of the Prince of Wales the town was illuminated in the evening on a grand scale. Mr. Wright, the electrical engineer to the Corporation, arranged for search-lights to be fixed on the tower of St. Nicholas Church and on the top of the West Pier pavilion, and the electric light was also used to good account in the magnificent illuminations at the Royal Pavilion.

The Copper Trade.—Copper consumption was even greater in the second than in the first fortnight of February, but at the same time supplies were more plentiful. On January 31 G.M.B.'s were £43. 17s. 6d., on February 14 £44. 5s, and on February 29 £46. 10s. The price has since sagged a little, but promises to recover again.

City and South London Railway.—The returns for the week ended March 1 were £946, compared with £953 for the corresponding period of last year, being a decrease of £7. The total receipts for the half-year terminating as above were £8,860, compared with £8,941 in the same period of the preceding year, being a decrease of £81.

Ripon.—At the monthly meeting of the City Council it was stated that the Gas Committee had held a long discussion as to electric works for the city, and eventually the town clerk was instructed to obtain from the Dean and Chapter information as to the number of lights they will require if they adopt the electric light for the cathedral.

Chelmsford.—The past year has not been a very prosperous one for the gas company. At the annual meeting it was stated that the sale of gas had decreased by £150, but Mr. Duffield (the chairman) pointed out that the company had great competition to fight against—first, there was Messrs. Crompton and Co., and then there were also the oil lamps.

Stafford.—The Gas and Electricity Committee have reported that an agreement had been entered into with the County Council for the lighting of the County Council buildings, the Judges' House, and Eastgate House with electricity, the annual charge being £175, with the payment of 8d. per unit for all current supplied over 1,312 units per quarter, the number of lamps not to exceed 1,200 8-c.p., or their equivalent.

Fenton (Staffordshire).—On the new powers sought by the tramways company coming up for discussion in the Urban District Council, the clause relating to the supply of electrical energy met with objection. Mr. Hughes remarked that the company would be empowered to put electricity in competition with their gas at Fenton, where the Council were contemplating the spending of £6,000 or £7,000 more on their gasworks.

Nottingham.—In consequence of the development of their business, Messrs. Caddy and Co., Limited, furnace engineers, have found it desirable to reconstruct their company so as to admit the capital necessary for its increasing requirements. This has necessitated the formal winding-up of Caddy and Co., Limited, and in future the business will be carried on under the name of "Caddy and Co. (Nottingham), Limited."

Wakefield.—It is stated that the scheme for electric lighting, which has been standing in abeyance for some time, is shortly to be proceeded with. The committee who have the matter in hand have unanimously decided to recommend the City Council to proceed with the work. The Local Government Board have sanctioned the borrowing of the money required to defray the cost of the works, and tenders have been accepted for the necessary plant.

Larne Electric Light Works, Limited.—This Company was registered on February 24 by Milward and Co., 188, Fleet-street, E.C., with a capital of £4,000 in £1 shares. Object: to acquire the business of an electric lighting company, as hitherto carried on by J. E. H. Gordon and Co., Limited, at Larne, Ireland; to carry into effect an agreement with the Larne Town Commissioners, and to carry on the business of an electric light and power supply company in all its branches.

Derby.—The promoters of the Derby and Ashbourne Tramways Bill have officially notified the abandonment of the Bill for the present session. The promoters named in the Bill were Sir Henry Wilmot, V.C., C.B., Bart., the Hon. Frederick Strutt, Mr. Afred Charles Duncombe, Mr. Godfrey Frances Meynell, and Mr. John Shaw. The proposed tramway was intended to be worked upon the overhead trolley system of electric traction. The total cost of the tramway was estimated at £31,172.

Devonport.—At the meeting of the Borough Council Mr. Councillor Waycott moved: "That a special committee be appointed to consider the expediency of taking into consideration the subject of providing tramway or other vehicular accommodation between our fast-growing suburbs and the town." In view of the extension of Keyham Factory and the consequent increase of population, he said it was necessary that such an important matter should be considered. Mr. Harvey seconded, and the motion was carried.

Cork.—The Electric Tramways Company, Limited, have given notice of application to be made to the Lord-Lieutenant in Council under the Tramways (Ireland) Acts through the Grand Jury of the county of Cork at the next spring assizes, and to the Corporation of the city of Cork, for an order in Council to authorise the construction, working, and maintenance of tramways in the city and county of Cork, to be worked by horse power, electrical, or other mechanical power, with all necessary works connected therewith.

City and South London Railway Bill.—The second reading of the City and South London Railway Bill will be opposed by Mr. Lowles and Mr. Harry Foster, who intend to move the rejection of the Bill. Their ground of opposition is set forth in a motion which Mr. H. C. Richards proposes to move—viz.: "That it be an instruction to the Committee to make such provision in the Bill as will prevent the taking or removal of the church of St. Mary Woolnoth, or the use of the site thereof, or the churchyard, for the purposes of the company's undertaking, or from being in any way injuriously affected thereby."

Eccles (Lancs.).—The Town Council have after considerable discussion confirmed the following resolution, which was passed at a special meeting on the 24th ult.: "That, pending the application for borrowing powers, it is not advisable to appoint a deputation to the Board of Trade, and that it is not expedient to apply to that Board or the Local Government Board for an extension of time for carrying out the electric lighting scheme." The Town Hall and Electric Lighting Committee recommended that £1,073 of their proposed expenditure be taken out of the general district rate and £737 out of the borough rate. The estimate was adopted,

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Aston (Birmingham).—Owing to the unsatisfactory nature of the electric light, both at the baths, the free library, and the Council Buildings, Mr. Vaudrey, C.E, has been consulted, and upon his recommendation the Highways and Buildings Committee have been authorised to put down a new steam-engine and dynamo, and to do other necessary work, at an estimated cost of £350, and the Urban District Council have now instructed the clerk to make an application to the Local Government Board for a loan for this sum.

Castleford.—The gas company have written to the Urban District Council in reply to a letter asking them to lower the price of gas and improve the quality, stating that they are unable to make any further reduction in price at present, as the consumption of gas had not increased. As to the quality, the gas had always been above the standard fixed by the Company's Act. The Council considered the reply very disappointing, and Councillor Townend said if the company did not try and meet them it would compel the incoming body to take steps by which there would be a considerable loss to the company. The matter has been referred to the Gas and Water Committee

Dover.—The electric light is proving very successful. The Dover Electricity Supply Company, Limited, commenced trading in April of last year, and already there is an equivalent to 4,600 8-c p lamps connected, and applications are steadily coming in. Their present system of supply includes 31 arc lamps for public street lighting, although the Town Council originally gave no guarantee that they would use the new illuminant. During 1895 the company were charging the maximum statutory price of 8d. per unit, but at the commencement of the present year the charge for current was reduced to 7d. for the first unit per lamp per month, and all current over this amount is at 5d

Preston.—The shareholders of the electric lighting company are well satisfied with the progress the concern is making In 1893 the income was £3,345 and the expenditure £4,345—a loss of £1,009. In 1894 the totals were respectively £4,778 and £3,783—a reduction in expenses of £571 and a profit of £995. Last year the income was £5 739, and the expenditure £3,339—a reduction in expenses on 1893 of £1,016 and a profit of £2,401. No dividend, however, is to be declared for the past year. The Corporation have decided to light several of the public thoroughfares and streets with electricity, so that altogether, it is believed, there are indications of progressive value in the Company's property.

Edinburgh.—The Lord Provost's Committee have recommended that no action be taken on the subject of a letter from Messrs. W. Dixon and Co, Glasgow, as to electric traction on the tramways This was expected to initiate a discussion in the Council. The recommendation was however, adopted by the Council, the Lord Provost remarking that up to the present they had not got anyone to tell them what electric traction would cost, unless that with the overhead wires, which the Corporation and the citizens had pronounced against over and over again. It was agreed to extend the public lighting by electricity along Morningside-road as far as Church-hill, and to light the West Port by the same means.

Derry.—At a meeting of the Corporation Lighting Committee Mr. Christie read a report, which, among other things, referred to the cost of running an electric arc lamp per year. Councillor Harper said he had gone very accurately into this question, and he found that in Newcastle-on-Tyne the Corporation paid £29 a year for each arc lamp; and the general average all over England was from £24 to £27, bringing up the average cost to £25 per lamp. Now, he would say that in the city of Derry it would cost a far larger sum, and in the future they had no prospect of it being less, because every day, every week, and every year it was increasing. To say that it cost only £20 a year to run an arc lamp was absurd.

Blackpool, St. Annes, and Lytham Tramways.—At the House of Commons Mr. Campion found that this Bill had complied with all the standing orders applicable to it at its present stage. The Bill authorises the Blackpool, St. Annes, and Lytham Tramways Company to revive the powers given them under their Act of 1893, and under this Act the company have to complete their authorised works within two years of the passing of the Act. They now seek to extend this period to 12 months after the passing of the present Bill. The promoters also desire power to lease and have running powers over the Blackpool Corporation tramways, to enter into working arrangements with the Corporation to acquire and work omnibuses, etc.

Wolverhampton.—At the general meeting of the gas company Councillor Jenks said he should like to hear if the company had been affected by the installation of the electric light. The Chairman replied that since the installation of the electric light the company had really had a larger number of customers. Alderman Owen said he believed there would be a large loss on the electric light undertaking in Wolverhampton. Alderman Annan said he did not think it would be a loss to the ratepayers if properly conducted, and he did not know any electric lighting scheme better managed than that in Wolverhampton. He did not make light of the electric light. The gas company must take care to keep well up to date with their works.

Catalogues.—We have received from Messrs. Dorman and Smith, of 94, Charing Cross-road, W.C., and Ordsal Works, Salford, a copy of their catalogue and price-list of electrical apparatus for 1896. It is a well turned-out book, and its contents covers the whole ground of electrical fittings. We have also to acknowledge from Messrs P. R. Jackson and Co., of Salford Rolling Mills, Manchester, a copy of their new catalogue of piston, pump, and packing rings. This firm has recently taken up the electrical engineering business. Their new shops are fitted with tools for the manufacture of dynamos, motors, switchboards, and electric light plant; and machinery for the general transmission of electric power in mills, ironworks, and mines.

Blackpool and Fleetwood Tramroads.—The Blackpool and Fleetwood Tramroads Bill has come before Mr. Campion, Examiner of Private Bills at the House of Commons, for investigation of standing order proofs. The Bill proposes to enable its promoters to construct tramways and a tramroad between Blackpool and Fleetwood. Its consideration has been postponed on various occasions, and Mr. Campion having found that the standing orders had not been complied with, as the promoters had failed to obtain the consent of all the local authorities having jurisdiction over the roads on the line of the proposed tramroad, Mr. Campion will report the non-compliance to the House of Commons in due course. This does not necessarily mean that the Bill has been dropped.

Newmarket.—At the meeting of the Urban Council a letter was read from the Board of Trade asking for the observations of the Council on the request of the promoters of the Newmarket Electric Lighting Company that the consent of the Council should be dispensed with. Another letter was also received from the Board enclosing a memorial forwarded by the promoters, signed by a number of leading residents in favour of the scheme. The Chairman said the surveyor had informed him that he would, if required, prepare a report at once on the question of supplying the district with the electric light. He suggested that the Board of Trade be informed that the surveyor was in a position to make a special report on the subject for consideration of the Council at their next meeting, after which they would reply more fully to the Board's letter. This was agreed to.

Stapleton.—The Clerk to the District Council submitted at the Council meeting a letter from the Board of Trade with reference to the Council's opposition to the powers sought by the Great Western Electric Light and Power Company, stating that the company had withdrawn their application for such powers; and he also stated that it was now understood that the Bristol Tramways Company would, by the end of the summer, apply for powers to extend their system of electric tramways to Fishponds; that the general fare would be 2d., and for workpeople 1d. Mr. Harris proposed and Mr. Tarlton seconded, "That the company be asked to fix the Fishponds terminus at the junction of Downend and Staplehill roads" This was carried. It was also resolved, upon the motion of Mr. Monks, seconded by Mr. Cool, that the company should be asked to put down wood paving inside the rails of the line.

Barcelona Tramways.—The directors' report states that no distribution of dividend is yet possible. In pursuance of the policy announced at the previous general meeting, the company has presented to the authorities a petition for the power to substitute electric for animal traction, accompanied by all needful plans, specifications, etc. The formalities to be gone through in Spain in matters of this nature are protracted and tedious, but there is no reason to fear that the application will not be granted. In view of the early adoption of the new mode, the directors are about to ask the shareholders to create additional capital to the extent, in all, of £150,000, divided into £50,000 in ordinary and £100,000 in 5 per cent. cumulative preference shares, which they estimate will be sufficient to cover the necessary outlay for the electrical installation and equipment, and the payment for the purchase of additional land.

Portsea.—On the spot where the main prison building used to stand, Messrs. Martin, Wells, and Co., of Aldershot (who are represented at Portsmouth by Mr. Moss), are erecting a new dockyard electric shop, which is to measure 348ft. in length, 42ft. in width, and about 28ft. in height. It will be built of brick, with stone dressings, and a slate roof. Inside, the latter will be supported by iron and wooden rafters. Plenty of large iron-sash windows are being provided. The floor is to be paved with wooden blocks, and a gallery will run around the building. On the ground floor rooms are to be provided for the electrician and his leading men, and the plans further provide for a drawing office, a plating-room, and extensive stores. Steps are being taken to fit the shop with the latest type of electrical machinery, etc. Additions and alterations are in progress whereby one portion of the old prison shoemakers' shop will be converted into a boiler-house, with engine, dynamo, and testing rooms adjoining.

Camberwell.—At a meeting of the Vestry Mr. Phillips, on behalf of the Special Electric Lighting Committee, presented an elaborate report with reference to the projected application of the County of London and Brush Provincial Electric Lighting Company for a provisional order to supply electric lighting in the parish, and setting forth the terms upon which the Vestry would consent to the order, among these being a provision requiring the company to sell their undertaking at any time after the expiration of 21 years. He now moved certain emendations upon the report already adopted, stating that the Vestry had applied to the Board of Trade for certain powers, which were greater than any powers granted to other parishes except those that had asked for the electric lighting to be in their own hands. The Board of Trade had granted the powers, but there were a few trumpery proposals that they declined to accede to. He asked the Vestry to accept the position laid down by the Board of Trade, because if they did not do so they would be disallowed the advantages already granted. The recommendations were carried.

Belper.—At a meeting of the Rural District Council Mr. Teale asked if they were to have any information as to the powers of persons to carry wires overhead for electric lighting purposes. The Clerk stated that a person could carry a wire over a public

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road without permission of the authority, providing it was over 30ft. from the surface of the road. Mr. Smedley had his name to the following notice of motion: "That in the opinion of this Council the time has arrived when we ought to have the necessary powers for lighting our streets with the electric light, and in order to do this the clerk be instructed to apply to the Board of Trade for a license authorising this Council to supply electricity under the Electric Lighting Act, 1882, for any public or private purposes within the area of the Belper Urban District Council for the next seven years, and that the resolution be considered at a special meeting of the Council to be specially convened for that purpose." The Clerk stated that a full month's notice would have to be given to comply with the Act, whereupon Mr Smedley consented to the motion being put down for consideration at the April meeting of the Council.

Fife Police and Telephones.—A deputation from Fife County Council has waited upon the Secretary for Scotland in Edinburgh to solicit his lordship's aid in obtaining from the Post Office telephone facilities for the police at more moderate rates than the ordinary charges. At present, it was explained, the cost of the messages which it was necessary to send per annum would, at the usual rates, amount to about £500. Sir Ralph Anstruther submitted that the County Council thought that if it were the desire of the Crown authorities that telephonic facilities should be increased, the Crown authorities should give them assistance in getting these facilities at a cheap rate. Formerly, the County Council paid a lump sum per annum to the Telephone Company, and they wished to follow a similar course with the Post Office, but the postal authorities said they had no power to make any such arrangement. Lord Balfour, in reply, said the request was one which ought not to have been made to the Secretary for Scotland, but to the Post Office Department and the Treasury, but he agreed with all they said of the importance of having rapid telephonic communication for police purposes.

Messrs. Crompton and Co.'s Proposed New Works.—The *Essex Chronicle* says: "It is said—and said, we believe, with truth—that the negotiations between Messrs. Crompton and Co., Limited and the trustees of the Johns estate, with reference to the acquirement of a site for the proposed new works near the railway line by the Writtle-road Bridge, are not progressing as might have been wished. This is distinctly bad news, for it will be a most unfortunate thing for Chelmsford if Messrs. Crompton should seek a site for the works in some other town. We most earnestly hope, alike for the sake of Chelmsford, the electric lighting firm, and the development of the Waterhouse Farm estate, that the hitch which exists will be speedily got over. On both sides of the bargain which has been contemplated we would respectfully urge moderation, so that terms may be agreed upon if possible. From the point of view of the future progress and prosperity of Chelmsford, this matter is of the utmost importance. In fact, it would pay the town to present Messrs. Crompton with a site rather than let them go elsewhere with these works, which would create a large additional wage and salaries fund for expenditure here, and improve the borough in every way."

Dublin.—The members of the Corporation have met in committee of the whole house to consider the rival electric tramway schemes. The proceedings were private, but it is stated that a resolution was adopted to the following effect: "That the United Company be allowed the use of electricity on their existing 17 miles at a rental of £300 a mile for each mile in which there was an installation; that they should not be given a monopoly of tramway rights in the city, and that the rental be subject to revision every seven years." A meeting in opposition to the electric tramway scheme has been held. At the beginning of the proceedings there was a great deal of uproar and confusion, in the course of which some rotten eggs were thrown from one end of the room to the other. The police were called in and they expelled several people. Business was then proceeded with, but the opposition being too numerous to be expelled *en masse*, the interruptions continued unabated to the end. On the report of the committee with reference to the proposals of the Dublin United Tramways Company and the Dublin Southern Districts Tramway being discussed in the Town Council, it was decided to postpone a decision on the matter for six months.

Foleshill (Coventry).—At a meeting of the Parish Council Mr. Ivens and Dr. Orton reported on their interview with Mr. Willmot, county surveyor, with respect to the dangerous condition of several of the tramway poles at New-inn Bridge and other places. Mr. Ivens said Mr. Willmot did not think the poles were so bad, but that it would be better to have them altered. He thought, however, that the greatest improvement would be to take away the loop lines at New-inn Bridge and Oak's-yard and he (the speaker) agreed. Dr. Orton alluded to the dangerous position of the poles at the places mentioned, and agreed that the taking away of the loop lines would be the best improvement. New-inn Bridge was positively dangerous. He moved that as Mr. Willmot and the deputation were of opinion that the poles were dangerous, the Council agreed it was advisable that the loop lines at New-inn Bridge and Oak's-yard should either be removed or the position of the poles altered. The motion was seconded and carried. An amendment that the Council proceed to the next business on the ground that the Local Government Board inspector's report stated that the trams were not to pass each other at the places mentioned, proposed by Mr. Carpenter, was not seconded.

Peterborough.—The following report of the Electric Lighting Committee was read at the Town Council meeting: "Mr. Batten proposed 'that the engineer prepare and produce on Friday, February 28, a statement giving detailed estimates of the annual expenditure in connection with the proposed electric lighting of the prescribed area in the borough, showing particulars of the working expenses, depreciation of plant and interest upon loan of £20,000 and proportionate repayment of the same within 25 years; also an estimate of the number of electric lamps at 6d. per unit required to provide for such annual outlay; and a separate account of the cost per annum of the street-lighting contemplated in the scheme, and of the account now paid for the gas lighting of the same streets.' This was seconded by Mr. Herbert. For the motion 10, contrary 8; the motion was therefore carried." Mr. J. Hunting challenged the confirmation of the minute, remarking that the discussion on Friday was a little heated. It was an utter impossibility for the details to be prepared by the time named, and he moved that the time be extended for three weeks. Mr. Batten said he did not object. Alderman G. Hunting seconded. Mr. Batten asked if the town clerk had heard when the commissioner was likely to come down. The Town Clerk said he had not. The amendment was agreed to.

Ealing.—At the meeting of the District Council the Electric Lighting Committee reported that they had considered draft plans for the provision of increased accommodation at the electrical works, and they recommended, in view of the many applications for electric light and the necessity of laying down extra machinery in the near future, that the plans should be put in hand and the necessary drawings prepared. The surveyor reported that the total of applications for private lamps had now reached 6,158, and of these 5,627 had been connected. Mr. Baker Hays asked how far they were from clearing up the initial expenses. The Surveyor: All but one of the original accounts have been paid. Mr. Baker Hays remarked that the incandescent street lamps seemed in every way admirable; they gave a much better light than the gas lamps. The Surveyor: Yes, the light is better and each lamp is a customer. Mr. Box: Have Messrs. Bramwell and Harris fufilled their promise to considerably reduce the original accounts? The Surveyor: Yes, in one instance an account was reduced by £1,100. The Chairman, reverting to the recommendation of the committee, remarked that the extra work was only what was anticipated, though it would require to be done sooner than was expected. The Council ought to feel gratified that that was the case. The recommendation of the committee was adopted.

Waterloo (Liverpool).—At a meeting of the Parish Council Councillor Taylor expressed the opinion that it would be advisable that members should have a printed copy of the proposed scheme of the electric tramways through the district and then they would be in a position to know what the promoters were asking for. The Clerk said the provisional order was printed. Councillor Williamson said he had not previously heard anything being said about the overhead or underground wires. Councillor Taylor said his impression was that the Council were going to support the scheme, their strong reason for doing this being that they required such a scheme, and were inclined to support anyone who promoted it. The Clerk said the overhead wires had been mentioned before, because at the last meeting a letter on the subject was read. Councillor Williamson said it had clearly been an oversight on his part, but it was immaterial to him whether the wires were overhead or underground. Councillor Johnson said he had not the slightest objection to the overhead wires. He had seen them in Dublin, and they were neither dangerous nor an eyesore there. The Chairman pointed out that tall loads of waste were brought down Oldham-road and these might interfere with the wires. Councillor Johnson said the highest load which ever passed on the road would not touch the wire. It was decided to hold a special meeting to consider the subject.

Morecambe.—An extraordinary general meeting of shareholders of the Morecambe Electric Light and Power Company has been held for the purpose of passing a resolution for voluntarily winding up the company. The meeting was called in consequence of a petition in bankruptcy lodged by the Bank of Liverpool, the company's bankers, who intimated their willingness to withdraw this if the company decided upon voluntary liquidation. Mr. W. B. Hodgson, chairman of the company, presided, and there was a fair attendance of shareholders. After several questions had been replied to, the resolution was adopted, Mr. C. R. Compston, Lancaster, being appointed liquidator. The secretary subsequently gave an account of the financial position of the company. The non-success is understood to be mainly attributable to inadequacy of capital, to the result of proceedings at the instance of residents in the vicinity of the generating station for nuisance caused by the alleged emission of noxious vapour from the motive power employed, and other unforeseen difficulties they had met with. The District Council have received authority for a meeting of ratepayers to carry out a provisional agreement for taking over the undertaking and mains of the company. The total cost of the installation for public and private lighting is estimated at £16 000, inclusive of £3,950 to be paid for the present mains. The latter are calculated to supply 122,000 units, in addition to the public lighting of the town and promenade.

Kingstown (Ireland).—In the Kingstown Police Court on Friday, before Mr. Byrne, Q.C., the directors of the Dublin Southern Districts Tramway Company were summoned by the Dalkey Township Commissioners for having failed to carry out the provisions of the order obtained by them for the construction of the electric tramway line by omitting to restore portions of the roads to a proper state of repair. Mr. M'Laughlin (Messrs. M'Laughlin and Ireland, solicitors) appeared for the complainants, Mr. Walsh, C.E., township surveyor, and Mr. O'Neill, town clerk, being in attendance. The defendants were represented by Mr. Dudley (Messrs. O'Connor and Dudley, solicitors), Mr. J. Clifton Robinson, C.E., managing director, and Mr. S. J. Fraser, the company's engineer, being also present. Mr. Dudley raised the preliminary objection

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that the magistrate had no jurisdiction to hear the case, contending that such summonses could only be heard before justices in England and Scotland under the provisions of the Tramways Act of 1870 Mr. M'Laughlin argued that the Act having been applied to Ireland afforded a summary remedy before a magistrate. Mr. Dudley said the order under which the company were making their tramway provided the remedy for cases of the kind. An application should be made to the Board of Trade, and that body could hold an enquiry. The present proceedings were apparently taken with the object of discrediting the company Mr. Byrne dimissed the summons, holding that he had no jurisdiction to try the case. There appeared to be a *casus omissus* in the Act with reference to Ireland, and the proper body to settle the matter was the Board of Trade. Mr. Dudley applied for costs His Worship said he would allow 10s. costs.

Bucklow (Cheshire)—Trouble has arisen between the Rural Council and the Altrincham Electric Company It appears that at a meeting of the Council of December 14, Mr Fawcus of the Altrincham Electric Supply Company, Limited, agreed to do certain things subject to the Council giving their consent to the company's application to the Board of Trade for a provisional order extending the area of supply by including Timperley and another road in Hale. One of the conditions under which the Council gave their consent was that the company would repay to the Council the cost of the repairs of the road after disturbance both in the old and new area of supply, in accordance with a scale approved by the Council. The Clerk now stated that he wrote to Mr. Fawcus, asking whether he declined to comply with the undertaking which he gave on that occasion, as if not it was not the intention of the Council to approach the Board of Trade with reference to the terms under which their consent was given. Mr Fawcus had replied to the effect that he could not consent to the extended operations which the Council now thought fit to give to the undertaking, as he contended that such undertaking referred to the new area and not to the old at all. He would be pleased if the correspondence which had passed between the Council and himself on this matter were brought before the Board of Trade should the Council think it desirable to do so. The Council unanimously decided that the Board of Trade should be acquainted with the full conditions under which their consent was given to the company's application, and it should be explained to them that if those conditions had not been agreed to at the time, their consent would have been withheld.

Kingston-on-Thames.—The business of the municipal electric lighting station commenced in October, 1893, and capital to the amount of £22,770, repayable in 25 years, has been expended. From the period of commencing until December 31, 1894, the total expenditure, excluding loan repayment, and interest, was £2,540. 19s 2d., and the total revenue £1,985. 19s. 7d. The amount receivable for the sale of current for the first quarter of 1895 was more than double the receipts for the corresponding quarter of 1894; and in May, 1895, current equivalent to 4,150 8-c.p. lamps was being supplied (including the illumination of the town hall, Corporation offices, and free library) So far as can be ascertained at present, the revenue for 1895 will clear working expenses but not any portion of the repayment of capital and interest. Mr. J. E Edgcome, A.M.I.M.E., A.M.I.E.E., the borough electrical engineer, states that as a large number of the present consumers came upon the mains at the end of the year, their accounts for 1895 represent only a few weeks' consumption and they would, of course, largely increase the revenue for the current year, exclusive of the customers likely to come on. The street arc lighting is charged at the extremely low rate of 2½d per unit instead of, as is frequently the case, street-lighting being charged at the same rate per unit as that supplied to private consumers. This, of course, made a great difference in the revenue returns for the works, although there was no difference to the ratepayers, as what they gained upon the increased revenue on the works they lost in extra payment for street-lighting. The 36 arc lamps have displaced 114 gas lamps, and the amount of light in the streets is five or six times greater than formerly. The charge to private consumers is 6d. per unit.

Ayr.—A special meeting of the Town Council has been held for the purpose of considering the minutes of the Lighting Committee. Provost Willock, who presided, explained that the object of the meeting was to get power to proceed with certain works for finishing up little matters in connection with the electric light. They had been obliged to call the meeting because the Lighting Committee had not powers. Mr. Grant stated that before proceeding to discuss the minutes he had a motion to make. Provost Willock ruled Mr. Grant out of order. Mr. Grant said it was a pity he was out of order, for there had been nothing but blunder after blunder. His motion was to appoint an electrical engineer to supervise the works altogether. It was agreed to charge £3. 10s. for the light supplied at the hospital ball, and on a division it was agreed that £10 should be the charge for the electric light at the art exhibition in the Carnegie Library. Mr. Hammond, electrical engineer, explained to the committee that the testing of the transformers had disclosed that they were one-third below the specified dimensions, and the meeting requested him to give a written report on them with the view to intimating a claim against Messrs. Swinburne for the whole extra expenditure which their failure entailed. Mr. Hammond recommended that seven transformers should be purchased as against those which Messrs. Swinburne had failed to supply, and in view of the urgency of the matter the committee approved. It was agreed to discuss this matter in private. Two offers for seven new transformers have been received—one by Siemens and Co. at £476, to be delivered in 11 weeks, and the other offer by Messrs. Fowler at £630, to be delivered in six weeks. It was agreed to delay the matter until the engineer was further communicated with.

Leeds.—On the minutes of the Highway Committee coming on in the Town Council Mr. Hannam proposed: "That the resolution passed by the Council on October 15, adopting the report of the Highways Committee upon tramway traction, be rescinded so far as regards the recommendation for an electric conduit system in the centre of the city, and that the Council approve the resolution of the Highways Committee to adopt the overhead electric system for the line from Roundhay to Kirkstall throughout, centre poles being used where practicable." After much consideration the committee came to the conclusion that the wisest course for them to adopt would be to visit Bristol and inspect the most modern overhead tramway electric system at work in that city; and having done so, they were almost unanimous in the opinion that they should be perfectly safe in asking the Council to adopt overhead wires along Boar-lane. Mr. J. F. Carter seconded. Mr. Mark Scott thought the committee should furnish an estimate of the shallow-conduit system. While not opposing electric haulage, he felt that the traffic in Leeds streets would be interfered with by the proposed system. Mr. Laycock, quoting from a circular, said the cost per mile at Bristol was £17,150, but Mr. Hannam subsequently said the capital cost of the four miles at Bristol was £50 000 The cost of the working could not be obtained. Alderman Firth expressed astonishment at the statement that the cost per mile at Bristol was 17,000 The compiler of that circular, he maintained, had left out of account the fact that practically a new permanent way had been put down for six miles, and that the £50,000 also included engines, cars, and all the electrical plant—in fact, the cost of the whole of the requirements of the Board of Trade. After further debate the resolution was agreed to.

Fareham.—A special meeting of the Urban Council has been held to consider further replies on the matter of the purchase of the electric light. The clerk read a letter from the Local Government Board to the effect that they were not prepared to reconsider their decision with regard to the sum of £200 and £120 as additional loans for the purchase of the electric lighting works. The clerk also read a letter from the Board of Trade stating that the Board would, on receiving an assurance in the form of a resolution of the Council that the wires referred to in Section 82 of the order should be placed underground within three months from the date of the transfer, be prepared at once to consent to the transfer. On the proposal of Mr. Abraham, seconded by Mr. Etherington a resolution was passed that the Council undertook to place the wires underground within the required three months. Mr Manville, with whom the clerk had had an interview at Portsmouth on the 15th ult., wrote that he should be prepared to report upon the plant, to prepare specifications, and to superintend the laying of the wires at the usual fee of 5 per cent on the contract, with a minimum fee of 75 guineas. It was decided to accept these terms, and to ask Mr. Manville to meet the Council in committee at an early date. Ten tenders for the proposed loan of £6,681 for the purchase of the works were received, and that from the Capital and Counties Bank, at 3 per cent. interest, with expenses of only £8 15s. for stamp duty, was unanimously accepted. The Council considered the negotiations which had been in progress between the agents of the opposing parties as to the final settlement. It was decided that the payment should be at 3½ per cent. interest from November 21, or 5 per cent. upon the debentures, and 3½ per cent. upon the shares if from March 17, and that the payment of the costs should be by instalments Eventually it was agreed that both parties should recommend counsel to select a date midway between the two named, and that the costs should be paid in four instalments.

Bristol.—The Sanitary Committee and the Electrical Committee having been appointed a committee to consider and report upon the question of introducing the overhead trolley system of electric traction into the city, they have met and have finally resolved to obtain the opinion of an expert as to the best system of electric traction, and to ascertain under what conditions electric traction is permitted in other towns, and what are the terms under which the tramway companies have the use of the streets. The Electrical Committee have had before them an application from the Stoke's-croft and North-street Ratepayers' Association for public electric lighting in those thoroughfares. The committee agreed to instruct the secretary (Mr. Prosser) to reply that the question of extensions generally was being considered, and that they hoped in the course of, say, three months to be able to report to the Town Council on the matter. The printed annual statement of accounts was before the committee, and was regarded with much satisfaction. The accounts are for the year ended Decembr 31, 1895, and show a gross profit of £4,019. 19s. 10d., as compared with £456. 7s. 11d. in 1894. The profitable demand for the light still continues. The total of borrowed money is £100,000 and of this £97,794. 11s. 10d. had been expended at the end of the year. The sum of £4,577. 11s. 9d. was received from the general district rate, or about a penny in the pound on the ratable value. In respect of the existing loans, £7,240 has been repaid, leaving £92 760 still owing. A balance of £1,786. 11s. 11d. is carried forward from net revenue to the current accounts. There were 408 301 Board of Trade units of electricity sold during the year, of which 251 708 were consumed by private consumers and 156,893 by the 99 public lamps which are supplied by the current. The cost of street-lighting for the 12 months was £3,447. 3s. 10d., or, roughly speaking, £34 per annum per lamp. This cost includes cleaning, replenishing, etc. It is not easy to compare the cost of these lamps with gas lamps, but, of course, the sum is considerably higher than for gas lamps. Against that fact, however, has to be set the greater illuminating power. At the request of the St.

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George's Urban District Council. the tramway company have agreed to a reduction of fares The Council have agreed to a further extension along the parish boundary.

Hampstead.—At a meeting of the Vestry the Lighting Committee reported that they had carefully and fully considered the question of what additional boilers would have to be laid down at the central electric lighting station for the winter of 1896-97; that they had considered the various types of boilers most suitable to the proposed new additions, and had received tenders and specifications from four firms; that, after careful consideration the committee were of opinion that the type of boiler manufactured by Messrs. J. Brown and Co. was the one most adapted to the space at the Vestry's command, and to meet their requirements; and therefore they recommended that two of Messrs. Ellis and Eaves's fire-tube marine boilers be ordered from Messrs. J. Brown and Co, Sheffield, at the price of £3,500, subject to that firm entering into such a contract with the Vestry as may be approved by the committee. Mr. Thwaites, chairman of the committee, in moving the adoption of the recommendation, said that it had become necessary to enlarge the station owing to the great increase in the number of customers. He also explained that it was necessary to decide upon the type of boiler before they could prepare plans for the enlargement of the existing buildings The recommendation was adopted. The same committee recommended that Messrs. Siemens Bros. and Co., Limited, be informed that the Vestry are not satisfied with the working of the arc lamps in Finchley-road during their two months' trial; that they are going fully into the matter, and will be in a position to communicate with them further on the subject shortly. This was adopted. Mr. Newton asked what was the cause of the electric light suddenly failing at the vestry hall on the previous Friday evening. The electrical engineer said that the failure was caused by the blowing out of a fuse. He had made arrangements for a periodical examination of the installation in the building to be made in order that nothing of the kind might occur again. It was resolved to lay a new underground telephone wire from the vestry hall to the stoneyard at a cost of £35.

Croydon.—The Electric Lighting Sub-Committee reported to the borough County Council that they had accepted the tender of Mr. S. Page for the electric lighting station buildings, offices, etc. They had received the following report from Prof. Kennedy: "The details as to clauses of contract and of specifications are now settled with the British Thomson-Houston, as also are final amounts of prices. The original tender of the British Thomson-Houston was drawn very fine indeed, and for the future good working of the station it has been necessary for me to add several matters. I have also been very anxious to avoid the chance of your having to pull up the streets again unnecessarily soon, as would be the case if the mains now put in were only just equivalent to the first instalment of lamps. All these matters are taken account of in the specifications and prices. I think that it would be as well that the condensing plant and pipes should be omitted at present. You will by this means save something like £1,100 out of the British Thomson-Houston tender, and the efficiency of the station will not be reduced. The actual cost of working will, of course, be somewhat greater to the contractors, as they will no doubt use more coal. But this section of the plant can be added whenever you think proper later on." The chairman of the committee had prepared a revised plan showing the proposed method of public lighting by arc lamps in the compulsory area, which the sub committee approved and recommended for adoption. The estimated extra cost of these lights over the price now paid for gas lamps in the above area is about £350 per annum. The sub-committee had considered a memorial signed by 59 residents in High-street, Friends'-road, and Park-lane, requesting that the proposed installation might be extended from Mint-walk, along High-street, up Friends'-road, returning along Park-lane to Katharine-street; but they did not recommend that any extension of the area be undertaken at the present time. Councillor Moss moved the adoption of the report. Alderman Miller seconded, and said that the mains now being laid for the central area were sufficiently large to extend to Addiscombe, Park-lane, South Croydon, and thereabouts, with, of course, additional sub-stations. They would also, doubtless, arrange to take the light to Norwood. When a demand came they would be prepared with a supply. With regard to the question discussed at the last meeting of lighting the compulsory area by means of arc lamps he had prepared a plan showing the position of 38 arc lamps, which would displace 62 burners now in existence. He was not prepared to give the Council the exact cost, inasmuch as since the last meeting Prof. Kennedy and the contractors had suggested a smaller lamp of 1,500 c.p instead of 2,000 c.p. They did not think that streets like North-end and High-street were sufficiently wide to require such powerful lamps as were originally suggested. The price of the smaller lamps worked out at £16 per lamp. The report was adopted.

Maidstone.—The question of disposing of the provisional order came before the Urban District Council last week. His Worship the Mayor presided. Alderman Charles Ellis moved the adoption of the committee's recommendations that the Council dispose of the provisional order to Mr. King for £500, the cost of obtaining the order, under certain conditions. He said the electric lighting order was obtained in 1892, and between then and now a considerable amount of discussion had taken place upon the subject. Mr. Hawtayne's scheme was rejected in 1893 by 17 votes to 3 and a resolution was then passed declaring that in the opinion of the Council it would be expedient to obtain a company or private firm to carry the out order. Accordingly, negotiations were opened with Messrs. Bourne and Grant, of the Electric Construction Company, but nothing was arranged, and at the end of 1894 the committee were reinstructed, being told to find some mode of disposing of the order. Acting on their fresh instructions, the committee made another effort, and at last got an offer from Mr. King, who said he was prepared to form a company to carry out the undertaking. Their report was presented to the Council on January 13 last. The terms upon which the order was to be transferred included the payment of a sum of £500 The Council were not to be bound to take any supply for public lighting, but if they did take electricity for that purpose they were to have it at 20 per cent. less than the cost to private consumers. The Corporation officers were to have the right of entrance to the company's works to see how things were going on; and there was a clause in the agreement for the regulation of the price to be charged for electricity supplied. If the company earned more than 10 per cent., the public must benefit in the shape of a reduced price On top of all this the Council could buy the undertaking, on giving six months' notice, at the end of 21 years, or after every subsequent five years at a fair market value as a going concern, with 10 per cent. added for compulsory purchase, excluding any consideration as to future profits. Another point to be considered was that the Council had had no application from the ratepayers, to his knowledge, for electric light. According to the unanimous voice of the speakers at the public meeting, electricity was to be the light of the future, and certain towns in which it had been installed were referred to—Brighton, for instance. But there was no comparison between that place and a quiet country town like Maidstone. Mr. Monckton (the town clerk) read a letter from Mr. King, stating that he was willing to increase his offer from £500 to £750 if the Council would carry out the heads of the agreement. Mr. Morling said they had not had the advice of a practical electrical engineer, and before they disposed of the order they ought to take counsel with some eminent man like Mr. Preece. It would be money well spent. Mr. Cox moved an amendment, "That in view of the resolution passed by the public meeting, and the further offer of Mr. King, the report be referred back to the committee for further consideration," and this was carried by 12 votes to 8.

Birmingham—The expenditure for the year 1896-7 on electric lighting, pumping machinery, storage tanks, and steam-generating plant at new meat market is estimated by the Finance Committee at £12,000. The directors of the Birmingham Electric Supply Company report that the amount of net profit, including the balance of £1.001. 11s. 9d. brought forward from last year, is £6,570. 11s. 8d. Out of this the directors recommend the payment of a dividend of 4 per cent., absorbing £3 629 9s. 9d., placing £1,920. 9s. 11d. to the credit of the depreciation reserve fund, and a further sum of £250 to the general reserve fund, carrying forward the balance of £770. 12s. to next year's account. On making the above appropriation, the total reserves and undivided profits will amount to £9,463 18s. 6d. There has been a steady increase in the company's business during the past year; the total number of 16-c.p. lamps, or their equivalent, on order December 31, 1894, was 12 138, and on the same date in 1895 the number was 18,199. The additions since the close of the financial year have brought the number up to 19,401. The expenditure on capital account during the past year has been £50 537. 2s. 1d. Considerable additions have been made to the plant and machinery at the Dale End works. Included in the capital expenditure are the buildings and partial equipment of the company's new stations at Edgbaston and Newhall-street, as also the underground mains that have been laid through a considerable portion of the company's new parliamentary areas. The directors also report that the two new stations are now in full working order. In the Edgbaston district the supply has been only available since October last, and the orders already received are encouraging. In the jewellers' district the demand for current, both for lighting and power purposes, considering the few weeks the supply has been on the mains, is most satisfactory. The reduced scale of prices adopted by the Board last year has had the effect of increasing the number of consumers and augmenting the company's business, and the slight falling off in the revenue caused by these reductions has now been overtaken, and justifies the policy adopted. The increase during the year in the use of motors has been considerable, and will no doubt in time became an important addition to the company's resources. To cope with the output in the future, additional plant has been ordered for the equipment of the Dale End station, and generating plant is in hand for the Newhall street depôt. As authorised by the shareholders at the last annual meeting, the registered capital of the company had been increased from £100,000 to £200,000, and in October last 10,000 shares were issued at a premium of 5s. per share, and, in accordance with the resolution passed at a special meeting of the shareholders, the £2 500 received for the premium has been applied as follows: to writing off preliminary expenses, £1 685. 2s. 4d.; to writing off expenses incurred in the recent registration and issue of new capital, £154. 10s.: and the balance towards the reduction of the charge on account of the company's provisional order, £660 7s 8d.—£2,500.

Lancaster.—At the meeting of the Town Council the Electricity Committee reported that they had instructed Messrs. Sharpe and Co., of Westminster, to oppose before the Privy Council the renewal of the patent of the Westinghouse Company on behalf of the Corporation The committee had appointed Mr. C M. Johnston electrician at the electricity works, at a salary of £100 per annum, he to perform such duties as the committee may from time to time determine, and to act under the instructions of the borough surveyor. On the motion for the confirmation of the minutes of the Electricity Committee, Mr. Alderman Smith drew attention to the very signal proof of the sound advice given by one or two of

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them last year, when they opposed the reduction in the price of current from 7d. to 5d. per unit Mr. Storey, himself, and the officials were all agreed that in offering current at 5d. they would certainly incur loss. The argument on the other side was that the reduced price would mean greater consumption, and it would be better than allowing the plant to be unemployed. Their worst fears had been realised in the balance-sheet, which showed that the electric light during the past year had been a loss to the town of £500 practically a penny in the pound on the rates. He did not think they had any right to supply electricity at a penny per unit less than it cost. Electric light was a luxury, and he did not suppose 5 per cent. of the ratepayers were consumers. Therefore they were making a present to a few at the expense of the many. It was true there had been some increase in the current consumed as the result of the reduction, but it was a very small one, the figures showing 58,000 units against 46,000 last year. He did not wish to move an amendment, but he thought it would be wise even now to revert to 6d. per unit and reduce the vexatious charge upon the meters. If they increased the price to 6d. they would have an increase in revenue of £240 or £250, which was pretty nearly equal to the deficit estimated for the coming year, which amounted to £280. Mr. Alderman Bell said Mr. Smith had hardly put the matter right. The recommendation of the committee was that the price be reduced from 7d. to 6d., and that they should get a current indicator, so that people who consumed light during a long period should pay less than was paid for a shorter period. If they had adopted that recommendation their loss would have been considerably more than £500, because people were giving up the light rather than pay the price, so that instead of an increase from 46,000 to 58,000 they would have had to report a decrease. He supported the action taken by the majority of the Council at that time. Mr. Hall said it was the intention of the committee to go thoroughly into the question at the end of the year. He voted for the reduction in price, but they were then told that electricity could be produced at a certain price, and they had found that information was not exactly correct. During the past year the cost of production had been reduced from 6d. per unit to a decimal over 3d., but. of course, that did not include interest and redemption. The increase in custom had been 27 per cent., which was not quite equal to the reduction made in the price. The minutes were confirmed.

PROVISIONAL PATENTS, 1896.

FEBRUARY 25.

4174. Improvements in the method of fixing caps to incandescent electric lamps, and in joining the leading-in wires of such lamps to contact plates. J. A. Sinclair, 55, Rowan-road, Hammersmith, London.

4175. (The sparkless) switch. J A. Fisher, Berea House, Gillott-road, Edgbaston, Birmingham.

4179. Improvements in electric road vehicles actuated by electricity. Thomas Machin, 36, Temple-street, Birmingham.

4207. Improvements in instruments for measuring electric currents. William Thomson (Baron Kelvin). 154, St. Vincent street, Glasgow.

4234. Improvements in electric lamps for vehicles. John Zimmerman, 45, Southampton buildings, Chancery lane, London. (Complete specification.)

4237. Improvements in continuous-current electric motors and method of regulating the same. James Devonshire. 70, Chancery-lane, London. (Elihu Thomson, United States.) (Complete specification)

4238. Improvements in windings for armatures of dynamo-electric machines and motors. James Devonshire, 70, Chancery-lane, London. (Walter H. Knight (United States) (Complete specification.)

4261. A new or improved electrical lamp. Herbert John Dowsing and Henry Sheehy Keating, 28, Southampton-buildings, Chancery-lane, London.

FEBRUARY 26.

4345. Improvements in the production of gas by means of electricity. John Henrique Dunn and Robert Graeme Elphinstone Dalrymple, 47, Lincoln's inn-fields, London.

FEBRUARY 27.

4369. Improvements in wooden casings or mouldings for electric conduit wires and cables. Charles John Wightman and Arthur Hudson, 2, Market-street, Bradford.

4371. Improvements in the construction of standards of electrical resistance. Andrew Duncan Hughson, 51, Wightman road, Harringay, London.

4393. Improvements in filaments for electric incandescent lamps. Godfrey Bamberg, 33, Barcombe-avenue, Streatham-hill, London.

4404. Improvements in electric switches. Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster.

4406. Improvements in and connected with electrical storage batteries. Edwin Augustus McLachlan, 11, Furnival-street, Holborn, London.

4427. Improvements in the construction of armatures for alternators and such like machines. Horace Field Parshall and the British Thomson-Houston, Limited, 70, Chancery-lane, London. (Complete specification.)

4432. Improvements in electrical resistances. William James Davy, 40, Chancery-lane, London.

4434. Improvements in or connected with moulds for use in the manufacture of secondary battery plates or supports. Frank King, 47, Lincoln's-inn-fields, London.

FEBRUARY 28.

4490. A compensated hot-strip ammeter for the measurement of electric current. Herbert Brandon White, 6, Cholmeley-villas Highgate, London.

FEBRUARY 29

4617. Improvements relating to electric railways. Carl Coerper, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED

1888.

9686. Electrically forging metals, etc. Lake. (Thomson). (Second edition)

1891.

17220. Commutating electric currents. De Ferranti. (Second edition)

1895.

2805. Electrically-connected mechanical instruments, etc. Crowley and others

4577. Electrically lighting miners' safety lamps. Ackroyd and Best.

6010. Magnetic clutch. Drake and others.

6630. Telephonic, etc., exchange systems. Urquhart. (Decker)

6654. Telephonic transmitters. Kotyra.

6791. Dynamo-electric machinery. P. R. Jackson and Co., Limited, and others.

14486. Motor switches. Devonshire. (Case.)

15225. Electric brakes. Devonshire. (Potter.)

18034. Electrical accumulators. Leitner.

19837. Arc lamps. Adams.

24706. Electric telegraphy. Marks. (Cooley.)

24905. Telephone transmitters. Rorke.

1896.

130. Electric accumulators. Gülcher.

452. Controlling electric motors. Lake. (Fiske.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1-1¼
—— Non. Cum., 6 per cent. Pref.	2	1½-1⅝
—— 4½ per cent. Debenture Stock	100	112-115 xd
Charing Cross and Strand	5	6¾-7¼ xd
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7¼
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	14-15 xd
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	130-132
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10-11
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2¼-2⅜
Edison and Swan United Ordinary	3	1⅝-2
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅛-1⅜
—— 7 per cent. Cumulative Pref.	2	2⅛-2⅜
Elmore's Copper Depositing	2	⅞-1
Elmore's Wire Company	2	⅞-1
Fowler-Waring Cables	5	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	15-16
—— 7 per cent. Preference	10	16½-17½
—— 4½ per cent. Debentures	100	109-112 xd
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	19½-20½ xd
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge Ordinary	5	7⅛-8
—— 6 per cent. Pref.	5	7⅛-7⅝
Liverpool Electric Supply, Ordinary	5	7⅛-8⅛
Liverpool Overhead Railway	10	13½-13⅞
—— 5 per cent. Pref.	10	15⅞-16
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅞-1
Metropolitan Electric Supply	10	12-12⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	115-119
National Telephone, Ordinary	5	6¾-7
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16-17
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6⅞
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	8½-9 xd
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8⅝
—— £4½ shares	4½	6¾-7¼
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	9¼-10½
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	5½-5⅝
Westminster Electric Supply, Ordinary	5	9½-10
Yorkshire House-to-House	5	9½-10 xd

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NOTES.

The Cinematograph.—Mr. Lumière's invention is to have a prominent position in the programme at the Empire Theatre.

Institution of Junior Engineers.—By invitation of the directors, about 150 members of the Institution of Junior Engineers have paid a visit to the National Skating Palace in order to inspect the machinery there.

Communication with Lightships.—The Royal Commission on the subject of electrical communication with lightships is approaching the end of its prolonged investigation. The taking of evidence has been concluded, and the final report is expected to be presented after Easter.

Telegraphs in the North.—According to the *Elektrotechnische Zeitschrift* a new connection is to be made in the extreme north between the Russian and Norwegian telegraph systems. The new line will run along the coast of the Arctic Sea to Vadsö, in Norway, and the Russian portion is expected to be ready in the course of the summer.

Aerial Graphoscope.—Mr. E. S. Bruce is to give a demonstration of the aerial graphoscope at the Kensington Town Hall on Wednesday evening next. The apparatus is one in which the principle of the persistence of vision is made use of to secure a lantern image projected apparently in space, and effects are produced which are not otherwise obtainable.

The Red Lion-square Accident.—The adjourned inquest into the death of Mr. A. F. St. George has been concluded, a verdict of accidental death being returned. According to the evidence, Mr. St. George was carrying on experiments in connection with the manufacture of candles, and having practically filled a cylinder with various substances placed it over a gas furnace, when the explosion took place. There was no pressure gauge on the cylinder.

Personal.—We are informed that Mr. S. Sudworth, who for some years has had charge of the dynamo and transformer shops at Messrs. Johnson and Phillips, has resigned his position, and has been appointed works manager to the Consolidated Telephone Construction and Maintenance Company at Coventry. Before leaving Charlton, the staff and workmen with whom he had been associated presented Mr. Sudworth with a handsome clock as a testimonial of their regard and a mark of their good wishes for his success in his new field of work.

Electricity in Dental Practice.—Dr. Levitt E. Custer has been writing to an American professional paper calling attention to the advantages of electric heating apparatus in dentistry. He lays especial stress on the precision with which it can be controlled and regulated. There is undoubtedly much truth in this, and another advantage is the absence of waste products of combustion. As the total amount of heat required is not enormous, and the work required to be done is expensive and of high quality, the field would seem to be an ideal one for electric heating work.

The Telephone Service.—Messrs. Camm, Bagshaw, and Co., Sheffield, have forwarded to the local Press some correspondence with the National Telephone Company. For the company's new list Messrs. Camm, Bagshaw, and Co. gave their trade description as "steel and file manufacturers." For this the Telephone Company wanted to charge them 5s., on the ground that a business description should be confined to three words. Messrs. Camm, Bagshaw, and Co. said they could not put it shorter, and they would not pay. There the matter rests at present.

Diamagnetism.—The Amsterdam Academy of Science has received a communication from Messrs. H. A. Lorenz and J. D. van der Waals on Mr. L. H. Siertsema's criticism of Mr. Duhem's proof of the impossibility of the existence of diamagnetic bodies. The authors consider that Mr. Siertsema has shown that what Mr. Duhem actually proves is only that the old theory of Poisson, or any similar theory, is only admissible in explaining the properties of such a body as bismuth on the supposition that the magnetic susceptibility is not negative in character, but only less than that of the surrounding medium. As applied to Maxwell's theory, Mr. Duhem's reasoning fails.

Uranium Carbide.—In another note mention is made of the carbides of the cerite metals. Mr. Henri Moissan has also produced carbide of uranium, and says that when heated with excess of carbon in the electric furnace the carbide is a definite and crystallised one, corresponding to the formula U_2C_3 ($U = 240$). Cold water decomposes it, a third of the carbon being given off in the form of a mixture of gaseous hydrocarbons, of which three-quarters are methane, and very little acetylene. Hydrogen is also present. The remainder of the carbon produces a mixture of liquid and solid carbides. It looks as though this reaction might prove a typical one for the carbides of several elements.

Sparks and Tramlines. — It is remarked by *L'Electricien* that it is well known that interruptions of the circuit caused by dirt and grit on the rails of electric tramways are liable to produce a good deal of sparking as the tramcars pass, and that this can only be prevented by the constant use of sweepers. On the Rouen tramlines, where they have at present a mixed service of horse and electric tramcars, this has not been done, and the result is that the street boys having discovered the effect of a stone being put under the tram wheels have made a regular practice of putting small pebbles on the lines in the Rue Jeanne d'Arc for the pleasure of seeing the sparks when the tramcar goes by.

Telephones in France.—It is stated that the arrangements for extending the existing through telephone service between Paris and Marseilles on to Cannes, Nice, and Monte Carlo have been all but completed, and that it is probable that within the near future it will be possible to converse freely with the Riviera at any of the Bureaux de Poste in Paris. It has further been stated in a Dalziel telegram that negotiations are pending between the London and Paris postal departments, so that the London and Paris telephone may be connected with the French inland trunk wires. It is understood that the French Government is seriously considering the practicability of telephone communication between Marseilles and Algiers.

Exhibitions.—It is confidently stated that at the Swiss National Exhibition, which opens on May 1, the electrical exhibit will probably be the finest ever seen. As the authorities have 12,000 h.p. at their disposal for experimental purposes, it is evident there ought to be no difficulty in the way of doing something very big. A meeting of the British committee in connection with the Hungarian Millennial Exhibition at Budapest this summer has been held. The meeting was presided over by the Lord Mayor, and the subject of transport was discussed. It is announced in the St. Petersburg *Viedomosti* that the Russian Minister of Finance contemplates organising an exhibition of Russian products in London, to be held next year after the closing of the Nijni Novgorod Exhibition.

Cerium Carbide.—Mr. Henri Moissan having worked out the metals of the alkaline earths, has extended his research into the carbides formed by the metals of the cerium class in the electric furnace, and has communicated

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his results to the Paris Académie des Sciences. Mr. Moissan has obtained a carbide of cerium to which he has assigned the formula CeC_2. When decomposed by water this does not give pure acetylene, like calcium carbide, but a mixture of acetylene, ethylene, and methane. (Something of this sort must necessarily occur owing to the higher valency of cerium.) There is also stated to be a residue of carbon compounds whose composition is not given. Of the alkaline metals lithium carbide has been prepared, and gives acetylene in the usual way.

An Interrupted Experiment.—The electrical engineer has many enemies, from the teredo, which ruins his submarine cables, to the mice, which devour his electric light mains. It has remained for Blackpool to furnish a new terror. The town of Blackpool possesses a menagerie, from which there recently escaped a porcupine. When recovered it was found to have devoured the insulation off two cables of a three-wire system, and to be desperately engaged on the internal strands. History does not yet say how the diet agreed with it. The *Pall Mall Gazette*, to whom we owe this interesting paragraph, has clearly not done justice either to the intelligence or the taste of that porcupine. It is obvious from its taking the trouble to bare both the wires that the animal intended to make a connection, and not merely a meal.

The Metric System.—The examiners of private Bills having decided that it would be contrary to parliamentary usage for the promoters of Bills to employ metrical measures in the specifications prepared by them pursuant to the Standing Orders, Mr. Arnold-Forster proposes to take the sense of the House upon the matter at the earliest possible opportunity. His probable method of procedure will be to give notice of an amendment to the Standing Order. In America they are prepared to go much further, for the secretary of the New Decimal Association has received information from the United States that a committee of Congress has under serious consideration a Bill to render the metric weights and measures compulsory in all official transactions, and it is reported that the majority of the committee are disposed to take some action. If the use of the metric system were mandatory in all departments of the Government, it is believed that the example would be followed in private contracts.

Trees and Wires.—The American supply companies seem to have a way of preparing trouble for themselves by taking insulated wires loose through the branches of trees. The insulation naturally chafes off. The *Scientific American* relates a case which happened in Brooklyn (New York), in which an arc light wire running through trees appears to have produced some pretty fireworks. The fire brigade were summoned, and their idea of a remedy was to pump water on to the trees. American firemen are bad to beat, but they did not succeed on this line. Ultimately they had to go to the supply company and ask to have the current switched off. It is said that the damage done to property amounted to £300. Probably this was the result of the heroic efforts of the brigade and their water, unless—and that is the only other supposition—live trees in America are estimated at £100 a piece. There is, unfortunately, no information as to what kind the trees were. There is such a difference between pine and poplar. But in Brooklyn streets it would be neither of those.

Motorcarts.—The Lord Mayor has presided over a meeting of the honorary council of advice of the International Horse and Horseless Carriage and Roads Locomotion Exhibition which it is proposed to hold this year at the Crystal Palace. Among those present were Sir David Salomons, Mr. Jacobs (president of the Institute of British Carriage Manufacturers), Major S. Flood Page, Captain Simonds (chief officer Metropolitan Fire Brigade), Prof. D. E. Hughes, Mr. de Lande Long (clerk of the Coachmakers' Company), Mr. G. T. Rait (chairman of the Crystal Palace Company), and Mr. E. Clarke. Sir David Salomons, in moving a resolution expressing the advisability of holding the proposed exhibition, remarked that since he introduced a deputation on this subject to Mr. Chaplin the Government had declared itself favourable to self-propelled conveyances, and regarded them as likely to solve in a measure the light railways question. He thought Mr. Chaplin was to be congratulated on having taken so much interest in the matter and on having promised to bring forward a Bill to deal with it. Mr. Jacobs seconded the resolution, and it was carried. It was announced by Sir David Salomons, who occupied the chair during the latter part of the proceedings, that Lord Kelvin had consented to join the honorary council.

An Accumulator Problem.—In the *Journal* of the Institution of Electrical Engineers there appears a communication by Mr. Desmond G. FitzGerald on the determination of the weight of dilute sulphuric acid to be allowed for in the construction of accumulators of which the effective capacity at a required rate of discharge is known. The steps in the solution of the problem are (1) to find the quantity of theoretical H_2SO_4 constituting an ampere-hour equivalent of this acid and multiply this by 2 and then by the number of ampere-hours of the effective capacity; (2) to find the quantity of water (Aq) required to produce with the calculated weight of H_2SO_4 acid of the percentage strength N; and (3) to find what additional quantity of acid of the strength N will in combination with the calculated quantity (Aq) of water give a residual acid of the percentage strength n. If Q ampere-hours be the effective capacity, and A the weight of H_2SO_4 corresponding to this capacity, then $A = Q \times 56{\cdot}4$ grains. Proceeding as indicated above, Mr. FitzGerald eliminates the intermediate quantities and ultimately arrives at a formula which gives the total weight of acid as equal to

$$A + Aq + (Aq \,.\, A + Aq^2) \div \left\{ \frac{100\ A}{n} - (A + Aq) \right\}.$$

The quantity Aq in this formula is, of course, determined in the second stage from the proportion

$$N : 100 - N :: A : Aq.$$

Diffusing Globes.—We have received a report by Prof. S. P. Thompson on the diffusing globes invented by Mr. Fredureau, of Paris. From the report and the description accompanying it, we gather that the globe is not unlike the old "dioptric diffuser" brought out by Mr. A. P. Trotter some 10 or 12 years ago. In some cases a hemispherical reflector is used above the lamp in conjunction with the diffuser, which is below. With this combination the results obtained by Prof. Thompson with a 16-c.p. lamp are as follows, the zero angle being vertically downwards:

Angle at which light was measured.	Amount of light with naked lamp.	Amount of light with reflector only.	Amount of light with reflector and diffusing globe.
0deg.....	8	17·5	34
10deg.....	8·5	17·5	24
20deg.....	9·25	18·75	22
25deg.....	10·25	15·2	16·25
30deg.....	11·5	15	12

These figures show that a strong local illumination can be obtained in this way, but we must protest against the claim that for effective purposes the light is doubled. In nearly all cases of interior illumination the walls require lighting as well as the floor directly under the lamps. Also the figures show that the reflector dome gives a better and more even

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distribution of light without the diffusers. This globe, which will be useful for table lighting, can be obtained from Messrs. A. and E. Cohen, of 2, Bury-street, E.C.

Telephones.—The Flensburg Chamber of Commerce has issued a circular to the other chambers of the German empire with reference to the telephone question. The circular points out that in some foreign States, especially the Scandinavian countries, in which Finland, with its excellent telephonic system on the Swedish model may be included, telephonic intercourse has attained an extraordinary development such as is unknown in Germany. Admitting that the postal and telegraphic organisation in these northern countries is not so highly developed as in Germany, and that the telephonic development may have been influenced to some extent by the fact, yet this is a reason which as must only be considered of minor importance, and the immense progress in Scandinavia must be attributed to the low charges which have existed from the beginning, and which have enabled the public to take advantage of the telephone, not only in the smaller but in the very smallest towns. A comparison is again made between Schleswig-Holstein and Jutland, and it is remarked the cause of the non-development of the telephone in Schleswig-Holstein must not be sought for in its physical characteristics, nor in a want of enterprise on the part of the Schleswig-Holstein public, but must be attributed to the demand having been killed by the heavy rates of subscription and onerous terms imposed. The result is that the number of subscribers in Jutland, which is thinly populated and without any large towns or any district of importance, exceeds the number of subscribers in the large towns of the German empire, Berlin and Hamburg only excepted.

Formula for Condensers.—Prof. Harold B. Smith contributes a short note to the February number of *Electric Power* on the subject of the construction of a condenser. A given capacity is wanted, and it is required to find the size. Starting from the theoretical formula for the capacity, $k\ A/4\ \pi\ d$, where k is the specific inductive capacity of the dielectric, A the area of the plate, and d the distance between the plates, it follows immediately on expressing the capacity in microfarads that the required area, A, is given by the equation $A = 1{\cdot}1313\ C\ d \times 10^7/k$, where C is the given required capacity. The value of k of course varies from unity in the case of air to as much as 5 for mica. (It is a quantity by no means accurately determined for most substances.) As a practical example, suppose it is necessary to design a condenser having a capacity of 1·5 microfarads with a dielectric of oiled paper 4·3 mils thick and tinfoil 7 mils thick, since the value of k for oiled paper is 2·67, the equation given above becomes $A = 1{\cdot}1313 \times 1{\cdot}5 \times {\cdot}0043 \times 2{\cdot}54 \times 10^7 \div 1{\cdot}67$, or the area required is 69,400 square centimetres, or 10,759 square inches. In obtaining from this the number of plates of a given size, it is obviously necessary to remember that on the two outer plates only one surface is effective, so that one more plate is required than the formula would appear to give. It is stated that the capacity of a condenser of 65 plates made in this manner came out on testing by one method exactly correct, and tested in another way correct within 2 per cent. With reference to this absolute accuracy, it may be observed that in most tables of the values of k a very considerable margin is allowed in the figures.

New York Railways.—The *Electric Railway Gazette* gives an account of the evidence of Mr. David L. Barnes, consulting engineer for the Westinghouse-Baldwin combination, given in the rapid traction investigation before the United States Supreme Court Commissioners. So far as New York was concerned, Mr. Barnes advocated the use of a passenger car equipped with motors and hauling trailers, and expressed the opinion that such a train could be operated at a speed of 60 miles an hour between stations, if the stations were a mile apart. In case it became necessary, he said, two motorcars might be provided for a train, but he did not favour the plan of equipping every car with motors, on account of the complication in wiring and the greater first cost of rolling-stock. Where the trains were operated without switching, and there was no loop track, he advocated the use of a motorcar at each end of the train when more than one was necessary, so that the motorman could control the train from either end of it. He had examined the profile of the proposed underground road, and saw no difficulty in operating electric cars upon such a road, at an average speed for express trains of 40 miles an hour and 15 miles an hour for local trains. He calculated that a seven-car train (one motorcar and six trailers) could be brought to a speed of 60 miles an hour within 47 seconds on a level track, and within a distance of 2,700ft. To reach a speed of 40 miles an hour would require 32 seconds and 1,200ft. He expressed the opinion that there is no choice in the matter of the system of propulsion for the proposed underground road—electric traction, he said, is the only feasible method. The cost of changing the present elevated roads over to electricity Mr. Barnes estimated at 8,000,000dol., and he thought the saving in operating expenses which had been realised by the Chicago West Side elevated road would reach 25 per cent.

Electric Locomotives.—The French Society of Civil Engineers has been discussing a communication of Mr. H. de Grièges on "The Progress of Electric Traction on Railways." This related mainly to what had been done on the Chemin de fer de l'Ouest by the electric-steam locomotive "Fusée," and to proposals to construct a new one of much larger size. Mr. de Grièges, however, stated that besides hoping, in the course of the summer, to have two of the Heilmann locomotives at work, the company intended to start electric traction on a conductor system on a line between Saint Germain Ouest and Saint Germain Grande Ceinture. After a great deal of discussion on the points of weight and speed in comparison with the ordinary steam locomotive, Mr. L. Rey asked Mr. de Grièges if he could state what was the relation between the work done on the pistons and the work returned at the draw-bar in his engine. Mr. de Grièges said that an effective return of 67 per cent. was obtained. At this Mr. Rey was openly surprised, and remarked that the best locomotives on the Nord Railway usually averaged about 55 per cent. Mr. J. A. Pulin thought there must be some mistake in the figure given. In reply to Mr. Regnard, Mr. de Grièges stated that the steam-engine used was not of the Willans type, but more on the plan of the engines used in torpedo boats. Each of the six cranks was worked by a single piston rod carrying two pistons instead of three. Ultimately the discussion went over to the next sitting of the society when Mr. Bousquet said the efficiency of 67 per cent. corresponded to an efficiency of 90 per cent. for the steam-engine, 90 per cent. for the dynamo, and 83 per cent. for the motors. This, however, was the efficiency at the wheel and not at the draw-bar. When allowance was made for the work done in moving the engine itself, the efficiency came down to 39 per cent. Mr. Réné Varennes said the electric locomotive contained a locomotive boiler, a steam-engine with quite a number of cylinders, a dynamo, another steam-engine with two cylinders used to excite the magnetic field, eight electric motors with their commutators and brushes, not to mention the bearings. It seemed to be a combination of complications, in which were

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united all the troubles of a fixed installation of electricity, an electric tramway, and an ordinary steam locomotive; and yet, Mr. Varennes complained, people had objected to the compound steam locomotive because it had four cylinders instead of two. After this, no one appears to have said any more.

The New Photography.—The interest displayed in the application of Prof. Röntgen's discovery to photographic purposes continues unabated. Nevertheless there seems little to note beyond repetitions and extensions of results already attained. Some time ago it was noted that the new radiations had been used to distinguish false pearls from true without removing them from their settings. Messrs. Abel Buguet and Albert Gascard, according to a communication made to the Paris Académie des Sciences, have ascertained that the same thing can be done with diamonds, as these are much less opaque to the Röntgen radiations than the heavy glass is that is used to imitate them. The new photography has also during the past week made its first appearance in a court of justice. In the course of a case at the Nottingham Assizes it was considered necessary to prove that an actress had suffered a displacement of the bones of her foot, and Röntgen photographs were put in and apparently used as evidence in support of the medical testimony. In the course of a lecture last week at the Society of Arts Mr. Campbell Swinton described an improved form of Crookes tube which he had employed for the new photography, and with which he had obtained superior results. In it the cathode plate was concave, so as to focus the cathode rays upon a point on the piece of platinum foil forming the anode. The foil was bent at an angle of 45deg. to the direction of the cathode rays so as to throw down the Röntgen rays, which in this case proceeded from the platinum, not the glass. The advantages of this tube were that it gave a sharpness of definition otherwise unattainable, and that there was less chance of the glass being cracked by heat. As to other points in the construction of the tube used, he said it must be made of soda, not lead, glass. Further, it must be exhausted to a very high degree, though what exactly was the best degree of exhaustion was uncertain. The best plan was to keep the tube connected with a mercury-pump, so that the exhaustion could be varied at will. He found that even a sealed-up tube would not retain the same exhaustion from day to day, owing to absorption of residual gases by the electrodes, condensation on the glass, etc. Mr. Swinton also exhibited an apparatus similar to what Prof. Salvioni, of Perugia, called a "cryptoscope," in which the fluorescence of a diaphragm contained in a tube is used to give a visible image of the "shadows" of the new rays. The material Mr. Swinton uses to make his diaphragm fluoresce is, however, barium platino-cyanide. At the close of the lecture, Prof. Dewar, who had presided, made some remarks, but refused to commit himself to any statement as to the theory of the new rays. Indeed, this matter seems to stand very much where it did. It may be noted that Mr. W. Lascelles Scott, of Forest Gate, has written to the *Times* to the effect that he has discovered that the Röntgen rays are capable of refraction under certain conditions, but unfortunately he gives no particulars. He also confirms the discovery already made on the Continent that the light from most fluorescent substances—for instance, platino-cyanide of barium, quinine, stramonium, fluoresceine, calcic sulphide, and that form of the old Bologna, or Canton's phosphorus, often utilised as "luminous paint"—contains a proportion of the new rays, or at any rate will, with a sufficiently long exposure, produce photographs through vulcanite and wood. Mr. Justice Wills has also written to the *Times* on the subject, but mainly to suggest that the proper name for the new process is "scotography." This is distinctly better than Mr. Le Bon's *lumière noire*. Mr. Scott would call the prints "vibriographs." The associations conveyed by this are anything but happy.

Oil Insulation.—Mr. Elihu Thomson has contributed to the New York *Electrical World* an interesting article on the dielectric strength of oils under alternating potentials. In the course of tests made under Mr. Thomson's direction, the fact was noticed that the striking distances of high potentials in insulating oils were in some way variable with the frequency of the current or potential waves, or upon the time during which electric stresses existed in a given direction through the medium, and this relation has been confirmed by other and later experiments. The general effect is found to be that discharges at low frequencies are capable of puncturing mineral oil layers up to from one-third to one-half the thickness of an air layer required to just resist puncture by the same discharges, while with high frequencies of equal striking distances in air an oil layer of one-thirtieth to one-sixtieth of the thickness of the air layer was sufficient to prevent discharges. At frequencies such as 125 per second a potential which would give $\frac{1}{2}$in. spark in air may puncture from $\frac{1}{3}$in. to $\frac{1}{4}$in. of oil between the electrodes, while at frequencies of 50,000 to 100,000 a layer of oil of $\frac{1}{4}$in. may resist puncture when the spark in air is as much as 8in. The high frequencies experimented with were such as were given by condenser discharges over an air gap, including a primary of a few turns, with a secondary of a single layer of some hundreds of turns immersed in oil. The discharges, in such case, are not continuous waves, but a rapid succession of oscillatory discharges with dead intervals of periods of inactivity intervening. The effect of carefully drying an oil was found to increase its insulating power. In these tests of the power of oil layers to withstand puncturing by high potentials a curious effect was noticed, which was that discharges under oil passed far more readily between balls than between sharp points. With balls of $\frac{1}{2}$in. diameter as terminals, and with low-frequency (125) potential differences, ranging from 100,000 to 150,000 volts, the space between the points could be one quarter that between the balls. The ratio between the length of spark in air and between sharp points in oil was 10 to 1 at 10,000 volts, and 8 to 1 at 15,000, while with balls these ratios fell to 2·4 to 1 and 2 to 1 respectively. When flat plates were substituted for the balls the striking distance in oil was still further increased as compared with the distance with points. The seemingly anomalous action of points under oil, so different from their action in gases or air, is certainly curious, and the usual injunction to avoid points and edges as conducive to electric discharge does not seem to apply in such media as oil, at least when the potentials are alternating and at ordinary frequencies. Mr. Thomson goes on to suggest, as a theoretical explanation of the phenomena, that only such part of the electrostatic field as is due to the ether is first established after electrification, and that the increase of such field due to the molecules of the substance, such as the interposed oil, is subsequent to the former. If this were so, the establishment of an electrostatic field at high rates in oils would present analogies with the case of magnetic fields in iron or metals. Some results of investigations communicated by Mr. P. Jaret to the Paris Académie des Sciences with reference to the behaviour of mica support this view. No explanation is given of the reversal of the conditions of discharge from points and balls. The free path of the molecules of the dielectric may have something to do with it.

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CLARKE'S PATENT COAL-CUTTING MACHINE.

The adjoining illustration (Fig. 1) is of an electrical coal-cutting machine manufactured by Messrs. Rosling and Appleby, of Bradford, Yorks, to Mr. T. B. A. Clarke's design and patent. We are informed that several of these cutters have been in use at the Lidgett, Nostell, Astley, and Tyldesley collieries for the past two or three years, and have given general satisfaction. It is claimed that the machine will hole hard bind at the rate of a yard a minute, and that it will hole in any material and in any part of the seam. At Nostell Colliery the cutters hole to a depth of 4ft. 6in. in hard bind containing iron pyrites, over 100 yards being done in a shift. Two men are employed, who lay their own rails.

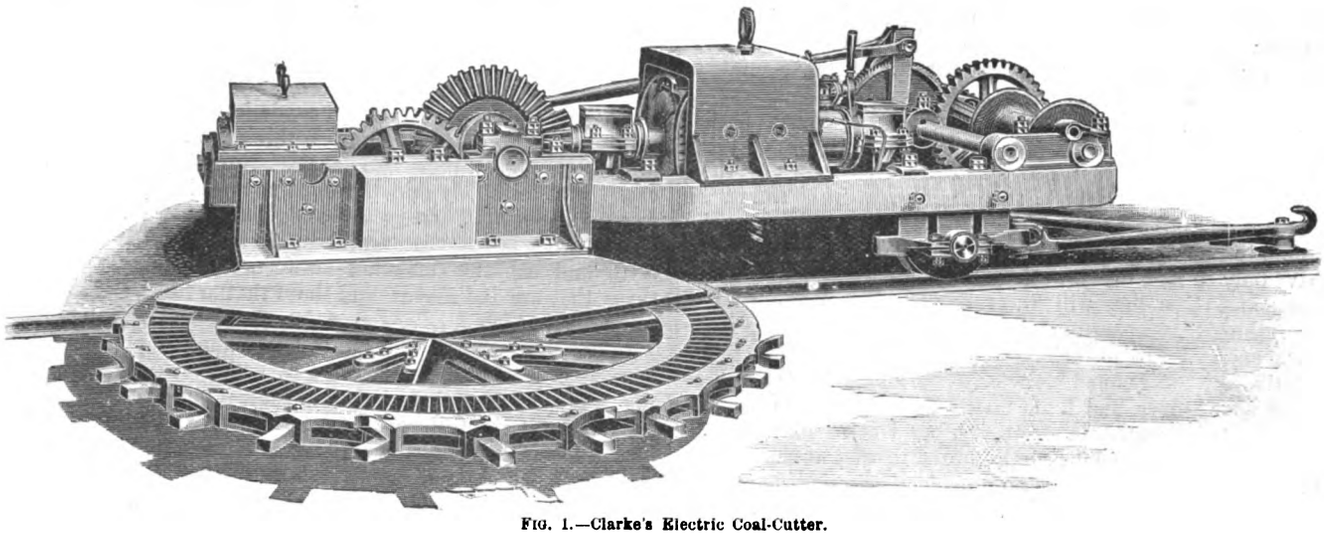

FIG. 1.—Clarke's Electric Coal-Cutter.

The machine is built of steel throughout, and is thoroughly enclosed and protected, being practically unbreakable. The motor is of iron-clad type, and is specially designed for the work, having the armature and commutator enclosed in a gas-tight casing, which is strong enough to thoroughly protect them from injury either by blows or other rough usage, or even a fall of the roof, and also from dust and dirt. A special brush gear is fitted to these motors which renders them sparkless. It will develop up to 20 h.p. at an emergency, but usually the work only requires from 7 h.p. to 10 h.p. The current is supplied at a pressure of about 400 volts, so that the motors can give off from 80 to 90 per cent. of the power supplied to the dynamo, half a mile away at the pit head. To colliery owners an important feature of the machine is the cheapness of working, which has been amply demonstrated at the various collieries where it is employed, as much as 10d. per ton, it is stated, having been saved over hand holing in a seam 3ft. thick. The dynamo manufactured by the same firm for driving the coal-cutter is also of special design, and made to stand the very heavy alterations in load which are bound to occur in this kind of work.

The second illustration (Fig. 2) shows the same firm's new type of dynamo machine, with circular bedplate and steel magnets. Great care has been taken in the design of these machines, especially as regards efficiency, durability, and small rise of temperature during continuous running.

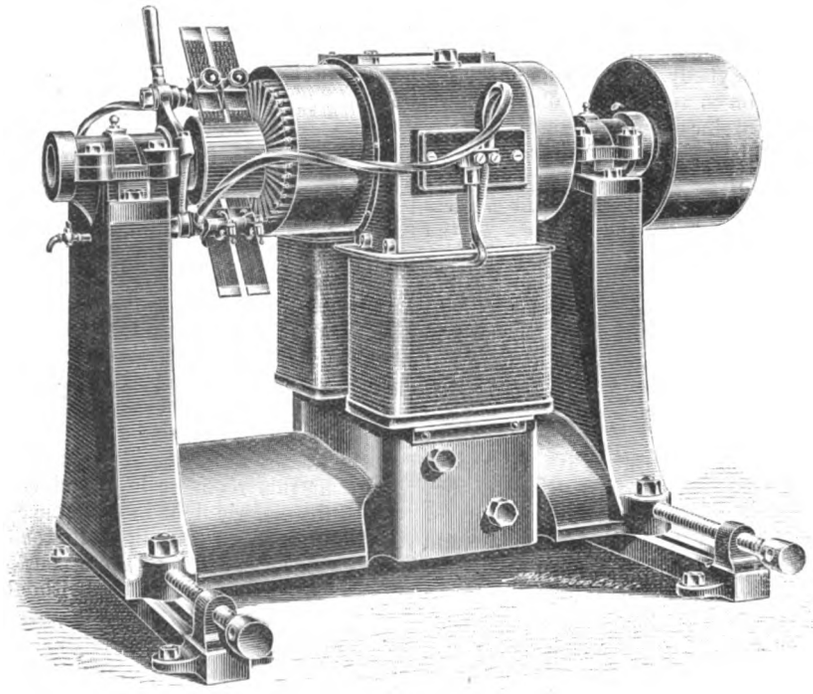

FIG. 2.—Dynamo used to Drive Coal-Cutter.

ELECTRICITY IN CONNECTION WITH BUILDING.

LECTURE BY MR. W. H. PREECE, C.B.

(Concluded from page 265.)

But in some places private enterprise produces equally great effects; for instance, in Newcastle, there are two companies competing against each other, and I was quite surprised only last week to receive notices that the rate of 4½d. per unit at which they were supplying current to our post office there, and subject to a discount of 10 per cent., was reduced still further by increasing the discount of 10 per cent. to 20 per cent. The result is that we are paying in

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Newcastle less than 4d. a unit for exactly the same material, if you can so call it, for which you are paying 8d. per unit. Of course, that is due to the fact that coal is cheap in Newcastle and dear in London. Swansea is a town near the coal district, and Swansea is a town where they have proposed not alone to supply electricity for electric lighting purposes at night, but also to utilise it for working their tramways by day; and if this scheme were carried out (I am not sure that it will be) it would mean this, that by having a continuous supply during 14 or 15 hours of the day they would be able to reduce the price to their consumers to probably as low as 3d. a unit. Now, that means that, while 8d. a unit is equivalent to gas at 4s., 6d. a unit is equivalent to gas at 3s., and 3d. a unit means a light equivalent to gas at 1s. 6d. That is probably what would be found in some of those towns in the coal districts which are able to apply their energy, not only for light, but for the movement of trains. I am not speaking idly on the subject, for everybody who wants to know what energy costs and what people pay for it have only to look every week in the columns of the technical Press and there they will find full records week by week of everything that appertains to the cost of production of electrical energy. One of the first questions asked is, "What is the relative cost of gas and electricity?" I have told you I was a gas shareholder, and I am interested in gas—I do not tell you I am interested in electricity, but I leave you to guess. My experience is, and I have indicated it, that at the present moment practically there is no difference between the cost of electricity and the cost of gas. Anybody can verify this for himself. If he has not got gas in his house or his office, he has some friend who has, so he has only to compare his electric light bills and his gas bills and he will find whether there is any great difference between the two. Now, I have seen a great many of these accounts, and I have seen great differences between the two. Sometimes the electrical light bill is less than the gas bill—often it is more than the gas, but if you take throughout the country the figures that are published every week, you will find that on the average there is no difference between the price of gas and the price of electricity. That is now. But, as I told you, the cost of production is lowering, and the result will be that the time is not very far distant when electricity will be considerably cheaper than gas. Of course, in my mind, I am comparing the ordinary burner with the ordinary electric lamp. The incandescent gas has recently come in, and that is going to produce a considerable change. There is no doubt that the incandescent gas gives you a very brilliant and a very beautiful light, and I cannot conceive anybody in his common senses who could resist the temptation to replace the old ordinary burner with the new beautiful incandescent lamp. In the first place, it gives a more brilliant light than the old burner; in the second place, it reduces the cost and the expenditure; and in the third place, it diminishes considerably the defects of gas, the principal consideration being the freshness of the air we breathe. Many people say—it has been said to-night—that the incandescent gas is going to interfere with the progress of electric light. I do not think so; and I do not think that the introduction of the electric light is going to interfere with the progress of gas. Each has its function. The function of gas is heat and power, not light; the function of electricity is light; and the function of the incandescent gas is to teach the public the benefit of a beautiful light. When they find that this beautiful light carries with it all, or nearly all, the objections of gas, it will mean that their next step will be the displacement of gas in any form for light, and the use of electricity. But gas being in the house, and gas able to be used for heating, gas will be applied to heating purposes, and so the business of the gas producer will not be affected, and, which is much more important, the dividends of the gas shareholder are not going to be diminished.

Now, with regard to lamps. One important feature of the electric light is the character of the lamp that is used. There is nothing more simple than the electric lamp. It simply consists of a very fine thread of carbon, which is contained in a glass bulb from which all the air or gas has been extracted. It is, in fact, a vacuum, but there are some remnants of gas left in that vacuum. These remnants are in reality a hydro-carbon gas, and in that hydro-carbon gas the filament will remain alight for some time. If this lamp were not a vacuum—if there were air there—the filament would be quickly consumed; the oxygen of the air would combine with the carbon which would generate carbonic acid and the thread would disappear; but being in a vacuum and in a very fine atmosphere of hydro-carbon, the result is that it burns for 1,000 hours or more. It is not combusted; it undergoes a certain disintegration on the surface, and through some electric action the particles of carbon of the thread are scattered and they cover the glass surface of the globe and dull it in course of time. These lamps were for 14 years the property of a company who, owing to the possession of a patent, held the monopoly, and the price charged was a pretty considerable one. The patent has expired and now the manufacture is open to all the world. The result is that we are flooded with lamps—lamps made in Germany as well as lamps made in England, and I think you all know the difference between those two labels. Now they have become cheap, and somebody said the word cheap simply meant the word "nasty." There was no doubt that we have been flooded with lamps that are cheap and nasty; the difficulty is to find out the difference between those that are good, those that are indifferent, and those that are bad. This is a subject to which I have devoted a great deal of attention. I cannot show you the tests now, but I want to point out to you the general idea of a method by which we can determine the quality of lamps before they are actually used. A lamp is supposed to have a life of 1,000 hours—that is, it ought to have a life of 1,000 hours—but we can in 1,000 seconds let it pass through a certain stage of its existence which, if carefully recorded, will give us the characteristic of the lamp, that will tell us in a few minutes its whole history. I cannot go through the process now because it involves a considerable amount of care, but I will show you what the process is. I switch the current on to this lamp and you see it gives the normal quantity of light. I now put on an increased current and this instrument—a voltmeter—indicates the voltage of the current passing through the lamp. You see not only is the brilliancy of the light increasing rapidly, but this indicator shows that the voltage is increasing too. If we had a photometer measuring the light at the same time as we are measuring the current and the E.M.F., we should have all the conditions that determine the life of a lamp. You see what a beautiful thing an electric lamp can be if we could afford to pass through it as much energy as is going through this lamp now. It is an ordinary 10 candle power lamp, and is probably giving 100 candle-power or more. Now it has broken at a voltage of 250. That lamp has passed through a history which, if carefully recorded, will give us all we want to know about that lamp. That is the test we are applying in the Post Office to all the lamps we can get hold of, and the result is that we shall soon be able to submit to the public a test that will enable us to select the bad from the good and the indifferent from both. Such is the lamp at our disposal for the purpose of introducing light into our buildings, and a lamp that has this particular merit that it does not vitiate the air we breathe. It is a lamp that we can put where we want it; it is a lamp that we can use when we want it; it is a lamp that we can apply to the decoration of our houses; it is a lamp that lends itself to the artistic tastes of the ladies of our households (the most important and particular factor in everybody's household); it is a lamp that gives us light by the consumption of energy without doing any harm whatever; and when we have that energy supplied to our houses at a rate of about half the cost of gas, who is there in this room or in the city of London who will not adopt the electric light in preference to any other?

Well, there are difficulties in the adoption of this light—for instance, the fitting up of our buildings. You cannot bring electricity into a house without there being a certain amount of danger. It is the same with gas, it is the same with fire, it is the same with candles, and it is the same, only much more so, with the common match. However, electricity, being the least dangerous of them all, still possesses danger—danger to person and danger to buildings—and here our Government departments and our insurance offices come in, and they supply us with rules and regulations by which, if we follow them, we ought to possess or obtain in our buildings the greatest possible security both to person and from fire. But, somehow or other, we all of us love, if we possibly can, to do the insurance company and the Board of Trade, and we want to do things cheaply. We put our work in the hands of the

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contractor who will do it at the lowest possible price. We do not take the trouble to have our work properly inspected by officers of the insurance companies or by those competent people who are to be obtained all over the country for the small commission on which the poor architect and the carpenter live—namely, 5 per cent. on the work that is carried out. The absence of this inspection has led to a good many troubles. However, notwithstanding all this, the number of accidents in this country is ridiculously small; and of the thousands of fires that take place, the number of fires due to electricity numbers mere units. I think last year it was only three or four throughout the whole country, while the fires from other causes numbered thousands.

The cost of wiring is coming down, and my experience in the Post Office, where we are wiring-up buildings all over the country as fast as we can induce the Treasury to give the funds, bears out this statement. In the General Post Office there are no less than 10,000 lamps supplied and lighted every day by machinery that we have in the building. So it is all over the country: Manchester, Leeds, Birmingham, Glasgow, Liverpool, Bristol, and all our great places are being fitted up with the electric light, and we have no difficulty in getting the funds for doing so Well, now, the cost, as I said before, is going down. At one time the cost of wiring a building was as much as £3 per lamp. I have known it done for less than £1 per lamp; the average is a little more. The cost of wiring depends entirely on taste and on the money expended in fittings. You can spend £50 on a single electrolier for your drawing-room. An electrolier may be made of any form or shape you like, and you can spend as much or as little money on it as you please; and if you are satisfied with plain, simple fittings there ought to be, there is no difficulty in fitting-up a building at £1 or £1. 5s. per lamp.

Then comes the mode of distribution. I have a board there which shows how the energy can be distributed through the house. It represents a plan of a house with four rooms, and each room can be put on separately and independently. The one charm of the electric light is, as I said before, that you can put it where you want it, and you can use it when you want it. You can use it for any purpose whatsoever, and my friend Mr. Probert, who is here, will show you a doll's house which he has constructed and fitted throughout with the electric light. I merely show you that to illustrate how simply electric light can be applied to any purpose. Could you do it with gas, could you do it with candles, or with any other mode of producing illumination excepting electric light? We can also tell exactly the amount of light to be applied to these diffe rent purposes. There is an extremely simple law that enables you to determine exactly the number of lamps or the amount of light you want to apply to any particular room or space, and it is simply this—that if you take one square foot of floor surface you want to expend on it an energy of one watt per square foot. A watt means really a measure of the energy that is expended in a lamp. Now, each of these lamps round this room is what is called a 16-candle lamp, and each lamp absorbs 64 watts. There are 746 watts in a horse-power; a horse-power will therefore supply energy for about 11 of these lamps. As each 16-candle lamp absorbs 64 watts, and as a rule in dwelling-rooms you have your lamps fixed about 8ft. above the floor, a 16-candle lamp will well illuminate 64 square feet. So that if you have a room of whatever size it may be, and you allow one watt per square foot of surface for a lamp 8ft. high, you have simply to calculate the number of watts for the whole area of the room; and if you cannot put your lamps 8ft. from the floor, but as they are here, about 35ft. high, you simply have to take the square of the distance and you can calculate to a nicety the amount of light required per square foot. Now, this room at the present moment is not illuminated to one watt per square foot. I know that by the ease or the difficulty with which I can read my own writing on white paper; but there are instruments called photometers that measure with extreme accuracy the illumination of a surface. By following this simple calculation, you are able to determine exactly the number of lamps that can be used and the expenditure of energy they absorb.

But there comes a difficulty; what is the reflective power of your walls? If your walls are painted white, half the number of lamps will give you the same light, but if architects will insist on panelling up their rooms with dark oak or teak panels, and put up marble pillars and pilasters, put in dark-green wall paper, and decorate their ceilings in a heavy manner, why, then, you must expect that the poor electrician will recommend to them a greater consumption of energy. There can be no doubt whatever, from experience, that with light distempered walls, as we are now adopting in our post offices—colouring the ceilings white and the walls as light as they can be—we get twice the amount of light that we should obtain if we were to follow the dictates of some of the æsthetical architects of the present day.

You should put your light so that it shall not offend the eye. The eye is the most wonderful, the most delicate, the most beautiful machine and apparatus that ever was designed or created. If there is anything that settles the point whether the human being is the result of design or of a concatenation of circumstances, as some people assert, the eye with its delicate mechanism is sufficient at once to bring it within the region of design. Automatically, the eye adapts itself to the amount of light that there can be available for it. Our ancestors were perfectly satisfied with the most horrible rush-lights. Nothing more appalling than the mode in which our grandfathers lived we in the present day can scarcely conceive. I can remember the time when we had moulded candles, and when the servants came round every hour and snuffed those abominable candles. Our theatres were lighted up by flambeaux. There were great torches suspended at the sides of the stage, and I remember reading of one man who said there was nothing he enjoyed so much in the theatre as the smell of the flambeaux.

Now, see what we have got. Look at this hall; and yet I am sure that we see very little better than our great-grandfathers who dined at the Carpenters' Hall under the influence of a tallow dip, for the simple reason that the eye adapts itself to the amount of light that is available for it. And that is why it is the greatest mistake in the world to place with the reach of the eye the bright and brilliant thread of one of these electric lamps. It dulls the eye If you come into a lighted room from the bright sunshine it looks dull, because the pupils of the eye are expanded by the brilliancy outside, and so it is that one has to study the eye in arranging the decoration of a room. The first law is, "never let the eye be offended by the brilliancy of the incandescent carbon filament." This is carried out to a large extent in nearly all our buildings. There is one of the banks in the City of London during the last week which has been lighted, not by the direct light from the lamps, but by reflected light of white walls, and I am told the effect is very beautiful.

So much for electric light. That is not the only purpose to which electricity can be applied. Electricity generates light because it generates heat. The only reason why these lamps show light so brilliantly is because they are heated to great brilliancy. The current passing first of all produces heat before it produces light. It is now being used to a very large extent for other purposes. Here is what is called a radiator. I happen to have in the Post Office a rather large room, and I found that my single fire-place during the cold weather was not sufficient to maintain the temperature of the room, so I had one of these radiators. The current passes through a wire that is behind the metal screen and becomes heated; not so hot as to become light, but quite hot enough to radiate heat, and the heat generated by the radiator is quite sufficient to raise the temperature in my office from 54deg. to 60deg., and it maintains the temperature of my office constant; so electricity can be applied to warming one's apartments. It can also be applied to boiling water. Here is a small kettle; I simply attach the block to the contrivance, and in about 10 minutes the water will boil. To be exact, it is worth knowing that it takes just 12 minutes to boil a pint of water, and it costs, with your energy at 6d. a unit, a farthing. Here is also an egg-boiler; but not only can you use electricity for making tea, for boiling water, for cooking steaks, chops, sausages, and all that sort of thing, but you can use it for no end of purposes—curling-tongs, flat-irons, and so on. We use it in the Post Office for heating up our wax. The quantity of sealing-wax used in a post office is marvellous; I cannot tell you how many tons are used per annum, but the consumption of gas and firing to maintain the heat to melt this wax is very considerable, and

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now, in Leeds, we have introduced electricity for the purpose so far with success.

We can also use this energy for producing power to produce motion in machinery; and one of the most useful purposes in hot countries or in warm weather is to move fans, or in India for moving the punkahs. In engine-rooms and workshops fans not only produce great circulation of the air, but extract the air also and maintain ventilation. Then, again, it can be used for working pumps, and it is used for working lifts. In London there is one near Bond-street, close to the electric light station, there is one in Brighton Town Hall, and in several other places there are lifts worked by electricity We are introducing the current for lifts at our post office in Leeds. You can use it for knife-cleaning, it is used a great deal for printing machinery, and there is a very ingenious thing, one of the latest developments invented—viz., a deck-planing machine. What with its ability to supply us with the purest and cleanest light, with the means it gives us to warm up our buildings and to supply us with means of cooking and looking after our creature comforts, what with its power to enable us to ventilate our chambers and to cool the atmosphere in heated climes, I think we must say that electricity possesses a superiority over all other forms of energy. In dwelling-houses, in offices, it adds to the health of our people, in shops it is almost imperative, in workshops it is the greatest comfort in the world to the worker—it improves his health and enables you to get more work out of him—and in theatres and places of amusement it enables everybody to go with comfort to himself and to everybody else. In the days of gas a visit to the theatre invariably resulted in a headache; now, with the electric light, nothing of the kind occurs.

When you look at some of the pictures of the past—only two or three years ago there was a picture in the Royal Academy of a Highland chief keeping his court in his house, supported on each side by stalwart servitors holding torches, the floor covered with heather, and there he and his attendants sat at dinner. Compare the position of the Highland chief and people of rank in the olden times, with their stinking, flaring torches, with the comfortable bourgeois of the present day in his suburban residence, whose rooms are clothed with elegant Turkish and Oriental carpets, whose walls are decorated with the highest efforts of art, and whose living-rooms and bed rooms are lighted with the purest and most simple form of light. So we come to the conclusion that at any rate, however well our great-grandfathers saw, we see with ten thousand times greater comfort; and we have succeeded by admitting these forms of energy into our premises in doing something that has added to the happiness and to the comfort of us all.

On the proposition of SIR ARTHUR ARNOLD, a hearty vote of thanks was passed to Mr. Preece for his lecture.

NOTES ON STEAM SUPERHEATING.*

BY WILLIAM H. PATCHELL.

(Concluded from page 241.)

Hick, Hargreaves, and Co.'s Superheater.—By the courtesy of the makers, the author has been favoured with the following particulars and tests of their superheating apparatus in a mill at Bolton. As shown in Fig. 4, the apparatus consists of a nest of U tubes, bent to a large radius at the bottom, which are placed at the back of a Lancashire boiler where the hottest gases from the flues impinge upon them. The box containing the tubes is divided down the middle by a vertical diaphragm, so that the saturated steam entering at one side passes down and up through the tubes, and leaves superheated at the other side. A by-pass valve is arranged to regulate the flow of steam through the superheater, because only a portion of the steam from the boiler is intended to be superheated. The Lancashire boiler to which the superheater is applied has a grate surface of 39 square feet; the heating surface in the boiler is 1,195 square feet, and in the superheater 120 square feet. The area of passage through the superheating pipes is 22 square inches. The boiler pressure is 100lb. per square inch. The test showed an economy in water of 9·6 per cent. per indicated horse-power per hour with superheating and 19 per cent. of coal. In the tests a portion only of the steam was superheated.

McPhail and Simpson's Superheater.—This apparatus is the invention of Mr. Hugh McPhail, and is manufactured in Wakefield by McPhail and Simpson's Dry Steam Patents Company. It consists of two parts: the superheater proper, and

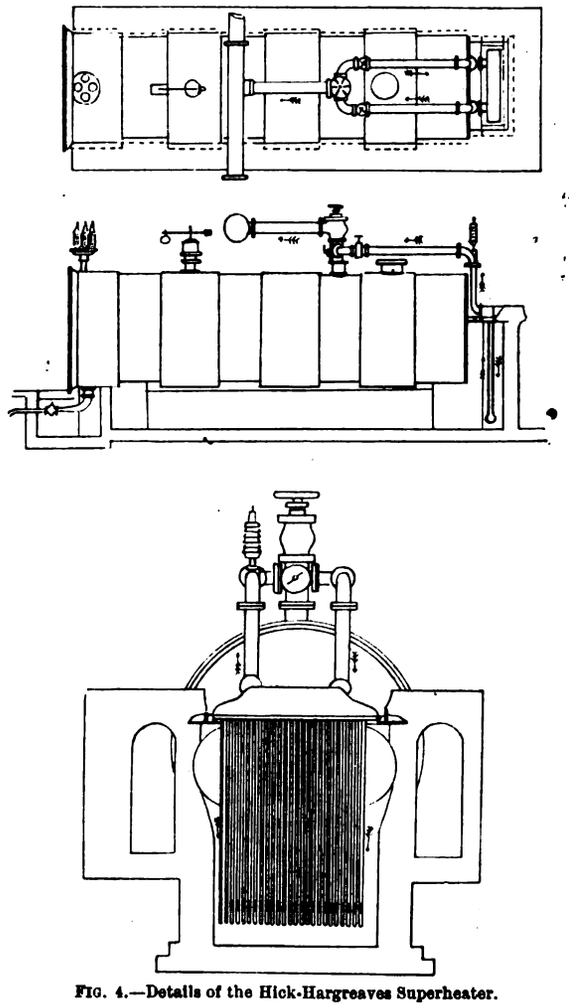

FIG. 4.—Details of the Hick-Hargreaves Superheater.

the steam-generator of radiating tubes, which distinguishes it from all other plants. As applied to a Lancashire boiler (Figs. 5 and 6), there are two nests of vertical steel tubes, expanded at top and bottom into cast-steel boxes, or "headers," as they are called in water-tube boilers; these nests are placed preferably at the back end of the internal flues of the Lancashire boiler,

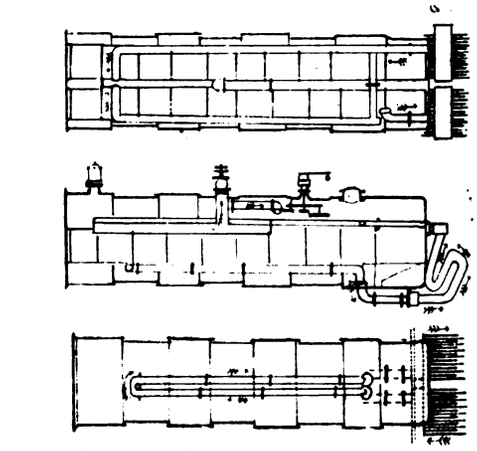

FIG. 5.—McPhail and Simpson's Superheater.

in the down-take, where the furnace gases impinge on them and pass between them. One of the top boxes is connected to the usual anti-priming pipe in the boiler, and the corresponding bottom box is connected to a block, which passes into the bottom of the boiler, and from which a copper pipe runs along the bottom of the boiler under the internal flues to the front end, and thence back again to the rear, where it passes out of the boiler and into the other bottom box. The second top box is connected to another copper pipe, which runs along the boiler over the internal flues, just below the water-line, and ends at the main steam stop-valve. The

* A paper read at the Institution of Mechanical Engineers. [We regret that we are obliged to condense this valuable paper.—ED. *E. E.*]

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course of the steam is from the anti-priming pipe to the first top box, then down through the superheating tubes to the first bottom box, whence it enters the boiler, and passing through the lower copper pipe gives up part of its superheat to the surrounding water, before leaving the boiler and entering the second bottom box. It is then further superheated in passing up through the second nest of tubes; and thence passing through the second top box into the upper copper pipe in the boiler, it again parts with some of its superheat, before finally leaving the boiler at the steam stop-valve. The final degree of superheat depends upon the proportion of the superheating tubes to the radiating pipes. The function of these radiating pipes is most important, as they give off to the water in the boiler the superheat which might be dangerous in the engines at times of heavy firing; and, when the fires are green after cleaning and the flue gases low in temperature, they prevent any possibility of the superheater becoming a condenser. They thus tend to keep regular the amount of superheat in the steam as it leaves the boiler. In its complete form this superheater has been tested and fully reported upon by several engineers in this country, among whom may be mentioned Messrs. Crossland and Michael Longridge. The results of some recent tests made by M. Armengand, at the works of Messrs. Isaac Holden, with a Lancashire boiler 28ft. long and 8½ft. diameter, with two internal flues 3ft. 3¾in. diameter, heating surface 2,287½ square feet, grate area 39 square feet, showed an equivalent gain of 30·9 per cent. in the weight of water evaporated per pound of coal when the superheater was used.

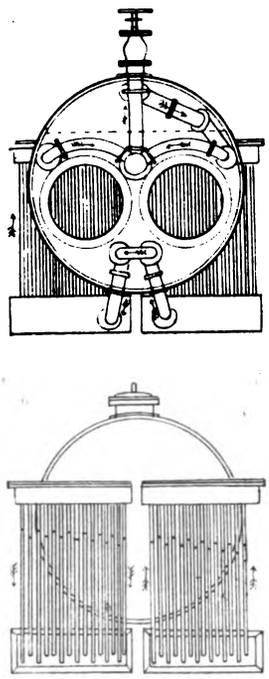


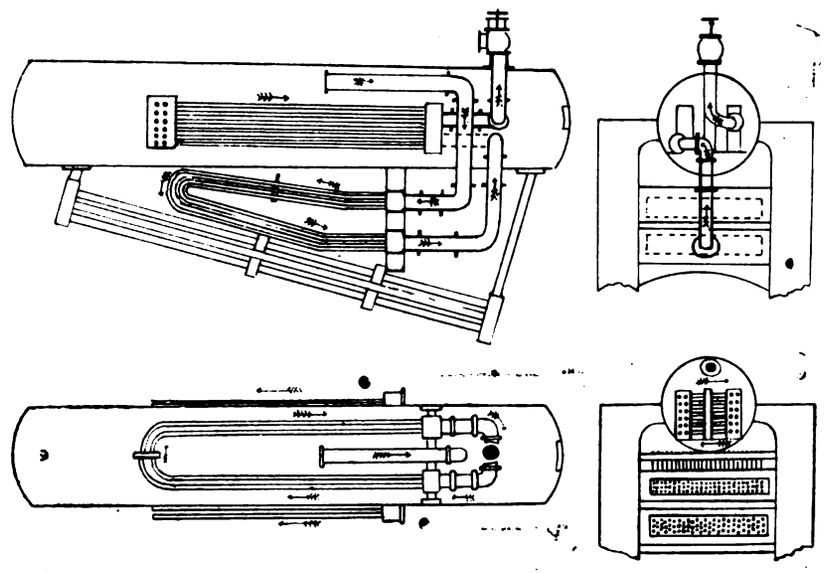
FIG. 6.—McPhail and Simpson's Superheater.

37·7 square inches, and through steam stop-valve 28·27 square inches. Complete tests of one boiler were made by Prof. Kennedy before and after the superheating apparatus was fixed, and the principal results with and without the superheater are given below:

	Without.	With.
Date of trial, 1893	June 20.	Oct. 17.
Actual water evaporated per pound of coal, lb.	8·89	9·65
Evaporation per pound of coal from and at 212deg., lb.	10·50	11·47
Evaporation per pound of carbon value, lb.	10·30	11·22
Coal burnt per hour per square foot of grate, lb.	11 3	15·5
Coal burnt per hour per e.h.p., lb.	4·74	4·12
Water per hour per e.h.p., lb.	42·1	39·7
Coal per kilowatt-hour, lb.	6·35	5·5
Water per kilowatt-hour, lb.	56·4	52·8
Efficiency of boiler, per cent.	68·4	74 9

The temperature of the steam in the main steam-pipe was 7deg. below the temperature of saturated steam when the superheater was not in use, and it was about 9½deg. above that temperature after superheating.

The superheat was practically lost in the range of steam-pipes between the boiler and engine. The increased capacity and ease in working of the boiler have been as marked in its subsequent use with the superheating apparatus; in regular work it is evaporating about 50 per cent. more than heretofore. At first the author had some misgivings as to incrustation forming in the superheating tubes from the priming water; but from examining them closely on several occasions after a run of 4,000 hours and more, and finding them perfectly clean, he is satisfied on this point. The top box, by its increase in area over the steam-pipe, gives a period of comparative rest in the flow of the steam, and acts as an efficient separator for the water or scum carried over. A steam-trap fitted to the box discharges any such accumulation regularly, thus preventing its being carried into the superheating tubes. The bottom box is also fitted with a trap to intercept any leakage from the steam stop-valve when the boiler is shut in. The first apparatus proved so satisfactory that a second was applied to the companion boiler in 1894, when the effect of the superheated steam in the pipes began to be marked by a decrease in the discharge from the drains and in the leakage from joints.



FIGS. 7 AND 8.—McPhail and Simpson's Superheater.

Another series of six tests made at the Kinleith Mills, Currie, Midlothian, on Lancashire boilers, each 28ft. long and 7½ft. diameter, having a heating surface of 920 square feet and a grate area of 36 square feet, showed an equivalent of 35·4 per cent. in the water evaporated per pound of coal and 2·6 per pound of combustible. This type of superheater was adopted by the author in 1893 at the Maiden-lane station of the Charing Cross and Strand Electricity Supply Corporation, but had to be considerably modified to suit the Babcock and Wilcox water-tube boiler, as it was found possible to put only one set of superheating tubes in the limited space between the top of the water-tubes and the underside of the drum, and only one set of radiating pipes in the drum, so that the arrangement represents only one-half of the complete apparatus as applied to a Lancashire or double-flued boiler. The arrangement is shown in Figs. 7 and 8. The saturated steam is taken from the anti-priming pipe to the upper box of the superheater, whence it passes down through the superheating tubes to the lower box, thence up into the radiating pipes in the drum, and through these to the steam stop-valve. The principal dimensions of the Babcock and Wilcox boiler are: 9×9=81 tubes, 18ft. long and 4in. diameter; total heating surface about 1,827 square feet; drum 23½ft. long and 4ft. diameter; width of fire-grate 5ft. 6in.; total grate surface 34·4 square feet. The principal dimensions of the superheater are: 75 superheating tubes of 1in. diameter, heating surface 355 square feet; 12 radiating pipes of 2in. diameter, heating surface 174 square feet; area through superheating tubes 58·9 square inches, through radiating pipes

Induced Draught.—The duty of the boilers having been increased to the above extent, and the priming difficulty being quite overcome, the only limit to the evaporation was the chimney draught. As the two boilers were fitted with an independent flue and chimney, they lent themselves readily to an experiment in this direction. Having considered several schemes of forced and induced draught as an auxiliary, the author finally decided on putting a fan in the flue at the back of the boilers. As there was no space available for any form of economiser between the boilers and the fan, no attempt could be made to diminish the loss from heat in the waste gases. The gain sought for was in the direction of increasing the capacity of the existing boilers, so as to render steaming independent of the natural effects of foggy or heavy weather, and by working the boilers at a higher rate to diminish the proportion of radiation losses, which are practically constant at all loads. The fan selected is a 72in. single inlet, made by Messrs. G. E. Belliss and Co., and driven direct by one of their tandem compound self-lubricating engines, having cylinders 3½in. and 6in. diameter and 4½in. stroke, working at 150lb. boiler pressure, and running at 300 revolutions per minute. The engine and fan were put in somewhat large for

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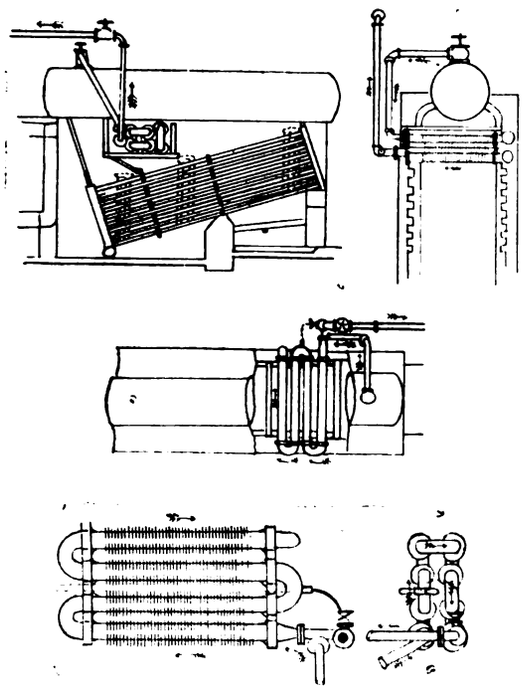
the estimated work, in order to secure slow speed and quiet running, with the result that within a few feet of the fan it is impossible to tell by the sound whether it is running or not; this is a marked improvement on many fan engines. A draught in the flue at the fan inlet equal to a 2in. water-gauge has been easily maintained. The usual method of working is to work the boilers on natural draught at times of light load, and then, as the load increases, to start the fan, close the by-pass in the flue, and work steadily at 1in. water-gauge. With this draught the superheater tubes are continually bathed in incandescent gases, but not the slightest trouble had been experienced with them. In order to test the thorough reliability of the tubes, and in view of the fact that trouble was most likely to arise, if at all, when getting up steam, one of the boilers was shut in, and the steam let down day after day for some weeks and then raised again with the induced draught; and there was an entire absence of any signs of irregularity or trouble. When the boiler is steaming freely, an iron bar inserted through the brickwork to a point near the ends of the tube soon becomes red hot, and the temperature as taken by a platinum coil pyrometer is about 900deg. F. At this temperature it appears to be of little importance whether the cooling agent is water or steam, so long as the circulation is kept up. This circumstance is most interesting in view of Mr. Durston's Devonport experiments, reported in his presidential address to the Institute of Marine Engineers, as to the permissible limit of temperature in a tube or tube plate, which he places at about 750deg. F.; and in view also of the grave doubts that are frequently expressed as to the safety of steel tubes exposed to furnace temperatures without a perfect circulation of water on the other side of the metal. What temperature the tubes actually reach the author is unable to state, but the steam coming out of them is over 600deg. F. The tube plates would be lower in temperature than the outer ends of the tubes, because the gases are drawn downwards and away from the plates by the draught. No trace of leakage at any one of the tube ends has yet appeared.

Schwoerer's Superheater.—The superheater illustrated in Figs. 9 to 11 is the invention of Mr. Emile Schwoerer, of Colmar, Alsace, who was for some time private secretary to the late Mr. G. A. Hirn. It was Mr. Hirn who first took up superheating seriously, and it is due to his energy that so much has been done with it in practical working in Alsace. Mr. Schwoerer's improvements were in the direction of reducing the space occupied by the apparatus, and he attained this end by employing a coil of pipe with gills on them both inside and outside, thus getting large surfaces in a small bulk. Regulation of the superheat by deflecting the hot gases away from the tubes, rather than by varying the proportion of the total steam passing through the tubes, is due to Mr. Schwoerer. By the courtesy of Prof. W. Cawthorne Unwin the author is enabled to give the tests of Schwoerer superheaters in Alsace, some of which were carried out by himself and others by Mr. Walther Meunier, engineer-in-chief of the Alsatian Association of Steam Users. The boilers were of the Elephant kind, with Green's economisers. The saving effected in the coal varied in the 12 different trials from 17·6 up to 25 per cent., and the economy in steam from 11 to 20 per cent. An application of the Schwoerer superheater has been made by Messrs. James Simpson and Co. to a Babcock and Wilcox water-tube boiler at the Grand Junction Waterworks, Kew.* The arrangement is shown in Figs. 9 to 11. The boiler is of the same size as those fitted by the author with McPhail's apparatus at Maiden-lane. Full details of the trials unfortunately cannot be obtained, but the saving effected is satisfactory. Tests were conducted by Mr. Osbert Chadwick before and after the superheater was fixed, and showed a saving of from 6·05 to 10·63 per cent. This type of superheater is also made by Messrs Frazer and Chalmers, Erith, who have one in constant use at their works.

Sinclair's Superheater.—Another form of superheater is shown in Fig. 12, which is due to Mr. George Sinclair, of Leith. There is here a departure from the usual method of securing the tubes, which in this apparatus are flanged and bolted to the cross inlet and outlet pipes instead of being expanded into them. In such positions an expanded joint is generally considered desirable, but here the joints are removed from the action of the hot gases, and a bolted joint gives much greater facilities for removing a tube in order to examine or clean it. In Fig. 12 the apparatus is shown in conjunction with a marine dry-back boiler, as fitted by Prof. Kennedy at the Edinburgh electric lighting station. The arrangement is very compact and should prove highly economical. The hot gases from the smoke-box at the front are led to the back over the top of the boiler, passing among the superheating tubes, thence down the sides of the boiler to the centre flue underneath it. The apparatus was described in Mr. Burstall's paper read at the last meeting (October, 1895), and in the discussion Prof. Kennedy stated that further tests were then in hand.



FIGS. 9, 10, AND 11.—Schwoerer's Superheater.

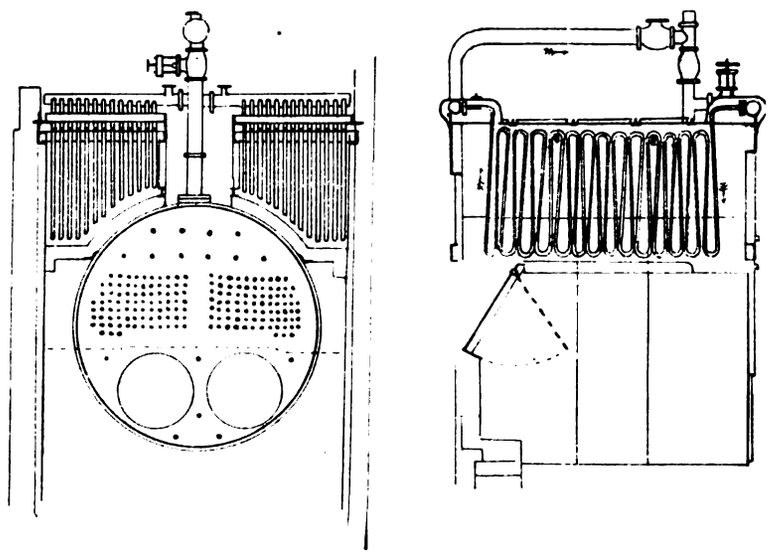


FIG. 12.—Sinclair's Superheater.

It is much to be regretted that so little has been done as yet with superheated steam at the engine. In nearly every instance the superheat appears to be gone, if not at the steam-chest, at any rate immediately on admission to the cylinder. But even under these circumstances the advantage of superheating is manifest from many of the tests given above, and it must be recognised that, although the steam may be cooled down again to the temperature corresponding with the pressure, it is still dry steam, and is a better working gas than the saturated solution of water-dust supplied by an ordinary boiler. The desirable amount of superheat has been generally considered to be the equivalent of the heat lost by initial condensation, but this does not obtain in practice. The amount of heat lost in initial condensation is generally from 20 to 25 per cent. of the total heat of the steam above boiling point. Tests with superheated steam show a saving of 20 per cent. with only 5 per cent. extra heat in the steam. This point has been brought out clearly by Mr. W. H. Booth in his paper on cylinder condensation, read to the Manchester Association of Engineers a few months ago, wherein it was shown that the amount of superheat is but little in excess of that necessary to supply the heat required for making good the latent heat which disappears as work during expansion. In conclusion, the author desires to thank the several gentlemen and firms who have kindly given him information and plans.

* *Engineering*, March 29, 1895.

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HIGH-VOLTAGE LAMPS, AND THEIR INFLUENCE ON CENTRAL-STATION PRACTICE.*

BY G. L. ADDENBROOKE, MEMBER.

(Continued from page 269.)

EFFECT OF USING HIGH-VOLTAGE LAMPS ON DISTRIBUTION.

On this point I do not think I can do better, as a commencement, than quote from my article in the *Electrical Review* of January 11, 1895: "How great a gain there is in distributing current at a higher voltage, and how much it simplifies the distributing problem, is not at first sight fully apparent, though everyone recognises that there are advantages. The advantages may really be said to progress as the cube of the voltage up to, say, about 200 volts. For let us suppose we have a station on all of whose circuits the lamps require 200 volts to incandesce them, instead of the usual 100 volts. In the first place, having doubled the pressure, we may extend our mains double the distance at the same current-density with the same percentage loss; but at the higher voltage the same current-density in a given sized main will give us twice the energy and light twice the number of lamps. Consequently, without increasing the sectional area of the mains, we can do four times the lighting with the same mains, or the same amount of lighting at four times the distance, with the same percentage loss. Then there is a further gain, for, since we can extend the mains four times as far from the central station with the same percentage loss, the area which can be served from a single station is 16 times greater at the higher pressure than at the lower. Presuming, however, that this argument is not pushed to its extreme limits, it is well within the mark to say that at 200 volts nine or ten times the area could be better served on the three-wire system from a single station than is now the case at 100 volts; not only is this the case with the feeders, but it extends in an even greater degree to the distributing system. At present there is no doubt that there is an inconvenient fall of voltage in the distributing mains, and the internal wiring of houses, which leads to irregular and unsatisfactory lighting, and which is under existing circumstances, whatever system is employed, exceedingly difficult to remedy. If by any means the voltage could be increased to 200 volts this would practically vanish, distributing mains might be carried three times their present distance from the feeding point, and the fall of potential in houses would be merely nominal on the present basis of wiring, instead of frequently amounting to 1-2 volts or more. By these means the number of feeding points in a given area would, of course, be much reduced. The same fittings and wiring as are now used would be applicable, and the voltage does not go beyond the Board of Trade limits." This was a general statement, made largely with a view to point out to manufacturers what a field it would open if they could produce a commercially satisfactory high-voltage lamp.

During the last 18 months manufacturers have seen the advantage of exploiting this field, with results which have already been detailed above. Consequently it is desirable to look a little more closely at the distribution problem under its new aspect, and I will therefore ask your particular attention to the figures which I now propose to lay before you. It is generally acknowledged that in the three-wire system at 110 volts it is not economical or very practical to distribute current at a radius of much more than three-quarters of a mile from the central station, except under special circumstances. The area which can therefore be economically served from such a station is about 1½ miles each way, or about 2¼ square miles. In his well-known feeder paper Mr. Crompton gave figures which he argued showed that a feeder on the three-wire system supplying 110-volt lamps could be laid and maintained, and would involve the same loss of energy, taken over the same day, as would an alternating feeder, including transformers, instruments, and switching gear, the length of the feeders in each case being 2,400 yards. These figures were strongly attacked by the alternating party, myself amongst the number; the most legitimate point of attack being that Mr. Crompton had assumed a loss of 30 per cent. at full load on the low-pressure feeder, which was considered excessive on account of the extra plant it would entail at the central station. Had Mr. Crompton put the length of his feeder at about 1,400 yards, or a little over three-quarters of a mile, and had he used a density of about 500 amperes per square inch—which is about the practical density—the loss would have been 16 per cent. for the continuous-current feeder at full load, and few alternating men would have seriously combated that on the whole the continuous-current feeder was as economical and desirable as an alternating feeder. The figures would then agree with the generally current comparison which I have mentioned above, and which I propose to use as a basis of argument in order to avoid disputes.

Now, from data I have collected, it appears that in such places as the centre of large towns there are perhaps 30,000 inhabitants per square mile, though ordinarily the population for a square mile of a town does not appear to exceed 16,000. A low-pressure station on the three-wire system with 110-volt lamps can therefore serve economically about 60,000 to 70,000 people in the centre of large towns, and about 35,000 in districts outside the centres and in provincial towns. If, therefore, we wished to light London, with its 4,000,000 population, on this basis, taking the average population at 25,000 per square mile, we should need, roughly, 70 to 80 stations to light the whole Metropolis, not counting the extreme suburbs. If, however, in the direct-supply system the voltage is double, the position is altogether altered, and a comparison between the transformer and direct-supply systems under these circumstances will lead to very different results from those so far given. Theoretically, if 220-volt lamps are used, we can extend the feeders four times as far as if 110-volt lamps are employed, and therefore the area which could be lighted from each station is 16 times as large. I do not intend to take full advantage of this facility in the calculations which I propose to lay before you, as I consider that the fall of voltage is too large in low-pressure central stations at present, and that the voltage of the lamps at different points of the distributing system is not kept as near the normal as it should be. In what I am about to say I shall therefore consider that, instead of four times, we extend our feeders a little over three times as far as before, thus securing better regulation and a smaller percentage drop in both the feeders and distributing system, together with the great saving in copper. If, then, we can extend the lighting radius three-quarters of a mile from a low-pressure direct supply station with 110-volt lamps, we can extend it, on the above basis, 2½ miles at 220 volts, which means that we can cover an area of 5 by 5, or nearly 25 square miles from one station—that is, 11 times the area we could before. Instead, therefore, of serving 60,000 people in the central districts, one central station would serve 700,000, and over a quarter of a million in the less central districts. Taking, then, the population of London as 4,000,000 without extreme suburbs, about six or seven stations would comfortably cover the whole area. Now this is a number which is directly comparable with the number of stations at present being operated by the gas companies, and to my mind it is doubtful if it would be desirable to reduce the number of stations below this figure for so large an area, even if it could be managed.

It would be interesting to go into this metropolitan lighting problem further did time permit, but it does not, and I must ask you now to turn your attention to the provinces. Take maps of Birmingham, Liverpool, Glasgow, and Manchester, and cut out a piece of tracing paper to represent 25 square miles on the same scale as the map. Lay the tracing paper over these maps and you will find that two stations, or at most three, will cover not only the whole of these great cities, but the suburbs for a couple of miles outside. For the general run of large towns one station would amply suffice, and for the smaller ones one station would, of course, permit of lighting over the whole area at a very small expense for mains. Before a technical audience like this, however, it will doubtless be more satisfactory to investigate a particular instance than to proceed further with general statements. At 220 volts pressure an ampere represents 220 watts; therefore one-third ampere represents 73·3 watts. Now at four watts per candle-power a 16-c.p. lamp takes 16 × 4 = 64 watts, and an 8-c.p. lamp 32 watts. We shall therefore be sufficiently near for the purposes of this calculation, and shall be allowing a sufficient margin, if we assume that a 16-c.p. lamp takes one-third ampere, and an 8-c.p. lamp one-sixth ampere at 220 volts.

Next consider the distributive system. There are two points needing attention: the first is, How far, and over what area, can we spread our network from the feeder points? the second is, What drop should we allow on the feeders themselves? But before going into these matters further we must settle what shall be our greatest drop from the feeder point to our furthest lamp on the network spreading from it. The variations which are permitted at present are too great, and would have to be reduced in time anyhow. I therefore do not intend to adopt the present practice as a basis, but to take as the limit an extreme fall of 2 per cent. on the distributing system from the feeder point to the furthest lamp at the tops of the houses—that is, lamps near the feeder would be 1 per cent. above their proper voltage at full load, and extreme lamps 1 per cent. below. This is, I think, as large a variation as good practice would allow, though it is less than half what is considered permissible now. Having settled this, the following data and table will enable us to see at a glance the best method of designing the mains, and their cost: (1) A bar of copper 1in. in section and one mile long weighs approximately nine tons, and its resistance is 1-22nd ohm, or 0·045. (2) Therefore a double conductor one mile long and 1in. in section weighs 18 tons, and its resistance is 1-11th ohm, or 0·090. (3) I do not think it will be necessary on the high-voltage system to have the third wire in a three-wire system more than one-fifth the

* Paper read before the Institution of Electrical Engineers, February 27.

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TABLE A.—Data Relating to Feeders on Three-Wire System Supplying 220-Volt Lamps—½ Ampere per 16 c.p. and ¼ Ampere per 8-c.p. Lamp.

Current density in amperes per sq. inch.	Loss in volts per mile of double con ductor.	Percentge fall of potential at full load.	Kilowatts available per square inch section of outers = 2·2 square inches copper.	Number of lamps carried by mains one square inch section = 2·2 square inches copper.		Cost per mile of copper at 6½d. per pound.			
						Per lamp alight at once.		Per lamp installed = twice lamps alight	
				16-c.p.	8-c.p.	16-c.p.	8-c.p.	16-c.p.	8 c.p.
		Per cent.				s. d.	s. d.	s. d.	s. d.
1,000	90	17	440	6,000	12,000	4 0	2 0	2 0	1 0
500	45	9·3	220	3,000	6,000	8 0	4 0	4 0	2 0
400	36	7·6	176	2,400	4,800	10 0	5 0	5 0	2 6
300	27	5·8	132	1,800	3,600	13 5	6 8	6 8	3 4
250	22·5	4·86	110	1,500	3 000	16 0	8 0	8 0	4 0
200	18	3·85	88	1,200	2,400	20 0	10 0	10 0	5 0

section of the other two, except, perhaps, in the distributing system. In fact, I understand Mr. Crompton considers the third wire could be done away with altogether as soon as the feeder gets a good load joined up to it, so that only the distributing system would need the third wire, these wires being joined together at the distributing point.

Consequently, the weight of a set of mains on the three-wire system—the two outers 1in. section, and the inner 1·5in.—would be 20 tons per mile; and the cost for copper at 6½d. per pound would be £1,210 for the copper in the mile of mains. Now at 1,000 amperes per square inch a main this size would carry current for 6,000 16-c.p. lamps, if perfectly balanced on the above basis, and the fall of pressure would be 90 volts in the mile, or 17 per cent. Such a fall of potential as 17 per cent. in the mile is excessive, and therefore we must arrange to work at a smaller current density. To enable the best current density to be judged, I have arranged the accompanying table (see Table A) which enables us to see the reduction in fall of potential which we get by reducing the current for a given section, and also the cost for copper which will be incurred for such density per mile run.

Now, it is not unusual in some low-pressure central stations to have falls of even more than 16 per cent. at full load on the longest feeder; but this is an undesirably great fall, save on exceptional occasions, such as Christmas week, or during a fog in winter, and I think, with the immense reduction in copper cost which the use of high-voltage lamps gives, it is desirable to work with smaller falls. Suppose we accept 250 amperes per square inch as a basis, it will be seen that mains on the three-wire system will cost us 16s. per 16-c.p. lamp alight at once, and 8s. per 8-c.p. lamp per mile, and the drop of potential will nearly be 5 per cent. Now, if we assume that current is supplied 2½ miles from the station as an extreme, as we did before, our longest feeders will be about this length, the drop at full load on the feeder will be about 12 per cent., and the cost of copper 40s. per 16-c.p. lamp, and 20s. per 8-c.p. lamp alight at once for the longest feeder. If we take the network as proceeding from the feeder points at the same current density—namely, 250 amperes per square inch—and if we agree that it shall extend rather over a quarter of a mile from the feeder point, to allow for irregularities, so that each feeder will feed a network covering half a mile square, it will be noted that the drop, including extra lengths of main for going round angles and into the houses, will be about 1½ per cent., and the extreme cost of copper per lamp alight at one time in the network will hardly be more than 4s. per 16-c.p. lamp, and 2s. for an 8-c.p. lamp, while the mean cost will be about three-fourths of this, and the mean drop of potential only 1 per cent.—and even this can readily be reduced by a little judicious adjustment. We therefore see that for feeders extending about 2½ miles, and a network extending a quarter of a mile further from the feeding point—that is, 2¾ miles altogether—the extreme cost for copper per 16-c.p. lamp lighted at once will be about 44s., and for an 8-c.p. lamp under 22s. This represents extreme lengths. The average length of feeders to cover the above area would hardly be more than 1¾ miles, or three-quarters of the above maxima, and the cost of the copper, on the average, in the distributing system will be reduced in like proportion. We shall therefore be correct in taking three-fourths of the above sums as the average cost of copper per lamp lighted at once from station to lamp, including both feeder and network, in a station covering a town area of equal density 25 square miles in area. This is, approximately, per 16-c.p. lamp, 33s.; per 8-c.p. lamp, 16s. 6d. Further, from practice and the tables in *Lightning*, we know that there are usually at least twice as many lamps installed as are required alight at once; therefore we may put the capital cost of mains for copper only at about, per lamp installed, cost of copper, 16-c.p., 16s. 6d.; 8-c.p., 8s. 3d. Now, it is fair to take 6 per cent. per annum as the sum to allow for interest and depreciation on the copper in the mains—say, 3½ per cent. for interest and 2½ per cent. for depreciation. At this rate, on the above capital cost, the annual cost for interest and upkeep comes out at under 1s. per 16-c.p. lamp and 6d. per 8-c.p. lamp installed. Further, on looking through the tables of consumption of current it will be found that 18 units per 8-c.p. lamp installed is a fair all-round average—at least, it is the average from *Lightning* for London and most of the provincial stations. At this rate, therefore, it will be seen that the upkeep and interest on capital for the copper in the distributing system comes to 0·33d., or one-third of a penny per unit of current sold; or, supposing the sum actually received for current is 6d. per unit, the cost for interest and upkeep on the copper in the distributing system represents less than 6 per cent. of the cost of current. Out of this cost it will be noticed that about three-fourths of the copper is in the feeders, and one-fourth in the distributing system. I may say that Mr. Crompton objects to the method of taking the consumption per 8-c.p. lamp installed as a basis of comparison, and I quite agree that it is rough and unscientific. Mr. Crompton suggests the relation between the annual output in B.T. units and the output which would be registered if the maximum load were continued day and night throughout the year. In this case he tells me the actual output would vary from the equivalent of full load for 700 hours in some country towns to 1,000 in parts of London, 1,300 in Kensington, and a much higher figure for the Pall Mall and St. James's Company; 1,300 hours corresponds to a load-factor of 15 per cent., though it will readily be seen that it is a figure of more comprehensive nature, and not exactly similar. I leave this question here, however, as, though very interesting, to discuss it further now would be out of place in this paper.

In order to complete the comparison made above, the cost of insulating and of laying the cables should, of course, be taken into consideration. In order to set this point at rest, Mr. T. O. Callender has kindly prepared for me data deduced from their experience in supplying and laying cables, which, as the result of a large amount of practice, are beyond cavil, and which show the average cost of cables laid as compared with the cost of the copper in them. These particulars are given in Table B:

Table B.—Total Cost of Insulated Cables laid complete, as compared with the Cost of the Copper contained.

Character of cables (separate).	Armoured, laid direct.	Plain, laid in solid bitumen.	Armoured, laid direct.	Plain, laid in solid bitumen.
Area of cable { Outer	Sq. inch. 0·50	Sq. inch. 0·50	Sq. inch. 1·00	Sq. inch. 1·00
Area of cable { Middle ..	0·25	0·25	0·50	0·50
Area of cable { Outer	0·50	0·50	1·00	1·00
Cost of cable laid complete, exclusive of excavation	19s. per yd £1,650 per mile.	25s. per yd. £2,200 per mile.	33s. per yd. £2,900 per mile.	42s. per yd. £3,700 per mile.
Excavation, cheap streets and lanes...	s. d. 1 3	s. d. 1 3	s. d. 1 3	s. d. 1 3
Excavation per yard, average run of trench in towns under macadam or pavement	2 0	2 0	2 0	2 0
Ratio of cost of copper (at 7d. per lb.) to cost of complete cable laid, as 1.....	2·5	3·1	2·2	2·3

Under asphalte or wood the cost of excavation will run up to as much as 15s. per yard run, but this item will practically be the same whatever system is used. Moreover, as only a few of the main streets in large towns are so paved, this item is not one which need concern us particularly in a general comparison, but must be dealt with in accordance with local circumstances in each case. It will be noticed that in the above table the middle wire is half the section of the outers; in practice it would not be necessary to have this more than one-fifth for the

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feeders, and in some cases it might be omitted entirely. The actual cost of feeders should therefore come out about 10 per cent. under the prices given, though I have thought better to leave the table as it was, preserving Mr. Callender's own figures. At these rates, for a two-mile feeder of armoured cable, working at a current density of 250 amperes per square inch, the cost, laid complete, would be about £55 per kilowatt for the maximum output; the fall of pressure being about 10 per cent. I think, therefore, that the whole distributing system—consisting of feeders, branches, local services, service boxes, and every other item, also providing for a fair proportion of the cables being laid under asphalte or wood, from such a station as I have described above, with a service extending 2½ miles in all directions—could be laid complete for £60 per kilowatt. This is a very moderate figure as compared with the sums now spent. If we assume that 8 per cent. is required to meet interest, upkeep, and depreciation on this outlay, and if we take the output of the station at 800 kilowatt-hours maximum load on the basis suggested by Mr. Crompton, it is evident that interest and upkeep on the distributing system would cost about 1½d. per unit of current sold for the whole distributing system; so that a charge of 1½d. per unit would cover all costs outside the station itself. From what we know of the cost of generating electric energy, it will, I think, thus be clear that, even in places where coal was expensive, a very good profit would be made by selling current at 4d. per unit for lighting and 2½d. for power purposes. In making this calculation I have assumed the same density of population over the whole area; but it is evident that this would very seldom be the case, as in nearly all towns at two miles from the centre the density of population is greatly reduced, which would mean a smaller proportion of long feeders, and consequently a less average cost per kilowatt output than I have taken.

I do not wish it to be assumed from what I have said above that the capital cost of a direct-supply station at 220 volts, with feeders and distributing system extending 2½ miles, as described above, would be as low as that for an alternating station at 2,000 volts, with transformers and 220-volt lamps, to cover the same area. It would not. Comparing feeders, I think, with the present prices of mains, and using the same class of insulation in each case, as is frequently done now—that is, not using expensive rubber cables for the high tension—the two systems are equal in cost for feeders 1½ miles long. As the distributing system will extend a quarter of a mile further beyond the end of each feeder, a direct-supply station on exactly the same lines is as cheap in capital cost for an area having a base of at least 3½ miles, and covering 10 square miles. Further, as something must be allowed to the direct-supply system on account of lower depreciation and greater safety and freedom from restrictions and ability to supply motors more easily, another quarter of a mile may easily be allowed on the feeders of the direct-supply station on this account, so that the systems compare together when the base of the area served is four miles, and the area itself 16 square miles, even if no accumulators are used. Although this is not as large as the area I have taken as a basis, what it means can be estimated from what has been said above as to the actual areas covered by large towns. I am, of course, assuming that 220-volt lamps are used on the transformer station as well as the direct. If we assume that the transformer station employs 100-volt lamps, of course the comparison would be much more decidedly in favour of the direct supply at 220 volts. There is no need, however, to go very minutely into these figures, because, though thoroughly practical, they do not represent what it is clear will be central-station practice in the future, as I do not think it probable that any direct-supply station in the future will be operated without accumulators.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 12.

DR. HOPKINSON (President) in the chair.

At last night's meeting of the Institution the following candidates were balloted for:

Foreign Member.—Fritz Nial Wolff, Aarhus, Jutland, Denmark.

Associates.—Samuel Ernest Andrew, King's-road Central Station, St. Pancras, N.W.; Wellesley Curran Clinton, University College, Gower-street, London; A. H. Lidderdale, White Hill, Berkhampstead; Harold John Lintott, Parkfield. Horsham; Marshall Osborne, 81, Manor-road, Brockley, S.E.; Robert Cornelius Quin, Kensington House, Hamilton-road, Brighton; Henry John Rogers, the Watford Engineering Works, Watford.

Students.—Alfred H. J. Graham, 27, Gower-street, W.C.; Archibald Victor Mason, Carbery Lodge, Ascot; William Edmund Miller, 33, Clarence-street, Loughborough; John Robert Milnes, 67c, Upper Tulse-hill, London, S.W.; Sidney A. Nash, 29, Cambridge-street, Loughborough: H. Ralph C. Partridge, Hockam, Thetford, Norfolk; John M. Robb, 48, Marlborough-Hill, London, N.W.; Reuben M. Sayers, 7, St. Peter's-square, W.; Frank S. Shaw, 32, Clarence-street, Loughborough, Leicestershire; Herbert Turnbull, 60, Toothill-road, Loughborough; Robert N. Tweedy, Redruth Cornwall; Charles Percy Walker, Shaw-lane, Headingley, Leeds; Leonard Wilson, 33 Clarence-street, Loughborough; Claude P. Wooler, Danemoor, Darlington.

The discussion on Mr. Addenbrooke's paper on "High Voltage Lamps" was then resumed.

The President said it was absolutely necessary that they should conclude the discussion on the paper that evening, as Mr. St. Clare's paper must come on at the next meeting. He suggested that those gentlemen who had any remarks to make should be as brief as they reasonably could.

Mr. Swan said the paper raised the question whether the time had not arrived when electrical engineers might arrange their plans for general electric supply on the assumption that incandescent lamps for a double voltage to what are now in vogue would be forthcoming on demand, and whether those lamps would be as cheap and as good as those of lower voltages. He passed over the question whether there was a possibility of a different kind of lamp of Crooke's tube or Tesla type superseding the lamp now known, but, at least, it might be said that the symptoms of its near approach were not sufficiently marked to make it necessary for the electrical engineer to take the possibility into immediate account. The question of the greatest moment was whether incandescent lamps of low candle-power, and requiring a voltage of 200 or 250 volts, could be made to compete in point of efficiency and cost with lamps of the lower voltage now in use. The demand for such lamps was a comparatively new demand, but fast increasing, and the pressure was sufficiently strong to compel the manufacturers to meet the demand by a supply at a moderate cost of a lamp which should be suitable for the double voltage, and which should have a fairly long life and a fair efficiency. From his own experiments he knew that it was possible not only to fulfil the very moderate requirements stated by Mr. Addenbrooke, but to go considerably beyond that, and as time went on the result would be both increased efficiency and diminished cost. A lamp of 200 or 250 volts of 8 c.p. was a more fragile thing than the 100-volt lamp of the same candle-power, such as at present made. Looking at the question from the point of view of the electrical engineer, instead of the lamp manufacturer, it was fairly clear that this practice would have a sufficient and perhaps more than additional recompense in the additional facilities that came from a wider and more economical distribution of current from supply stations, which was a very important advantage, and fully justified a very considerable sacrifice in obtaining it. In new work he saw no other objections to high voltage lamps than those Mr. Addenbrooke had named, but great care would have to be exercised in existing installations. Mr. Addenbrooke had given two years for the thorough elaboration of the higher voltage system, but in his opinion that was a very liberal allowance; so far as the lamp manufacturer was concerned, he did not require it. To go from the question of high voltage to that of efficiency, the real difficulty here was connected with the employment of the lamp on a higher voltage. The fluctuations of pressure to which lamps were subjected were commonly too great to give the high-efficiency lamp a fair chance. At 2½ watts per candle the filament was heated to a very high temperature, and a rise of voltage beyond that was very trying to the life of a lamp. They all knew that even the best lamps of that character would not bear very long any extra pressure producing a super-high efficiency and a super-high temperature. In nearly all the public supply companies the normal voltage was often exceeded by more than 5 per cent., sometimes 10 per cent. When such extra pressure was brought, the result was disaster, and the lamps gave way. But given a voltage that never rose more than 1 or 2 per cent. above the normal, there was no difficulty in realising that economy of current which was obtainable by the use of a 2½-watt lamp. He hoped in the near future it might be practicable to make a much more general use of lamps of high efficiency than under existing circumstances would be convenient or economical.

Mr. Stearn quite agreed with Mr. Addenbrooke's view that economy in lighting could be more easily reached by high pressure and low temperature than by high temperature and low pressure. So far as duration was concerned there was not much difficulty; where the pressure was regular, satisfactory results could be obtained. The difficulties in the way of the construction of high voltage lamps were mechanical ones, and he proceeded to explain how the filament could be fixed in a lamp so as to get a single filament lamp instead of a double as at present.

Mr. Snell said there had been very little trouble with the higher voltage lamps at St. Pancras, and **Mr. Robertson** remarked there was no difficulty in the new lamps from the makers' point of view.

Mr. Geipel thought no one would deny that lower voltage lamps could be run at a better efficiency than the 200-volt lamps. He would like to see Mr. Stearn's improved filament applied to the 8 c.p. 100-volt lamp.

Mr. Epstein, Mr. Campbell Swinton, and **Mr. Patchell** continued the discussion, and were followed by **Mr. Handcock,** who thought that at 100 volts the limit had been reached. He agreed with Mr. Swan as to the absolute necessity of a steady voltage, and thought the supply company should test and supply the lamps.

A communication from **Mr. Baynes** was read, in which it was suggested that high efficiency 100-c.p. lamps might be used two in series on the higher voltage, say, in shops, and the **Chairman** remarked that in Manchester they had taken all five wires into the Town Hall, and used as many as four lamps in series.

Mr. Addenbrooke then replied, acknowledging the assistance given him by Mr. Crompton and others in preparing his paper.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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PARALLEL RUNNING.

The question of parallel working of alternators has exercised the minds of engineers and electricians for several years. The changes in the theories of the subject have been many, and in few cases have really practical results been obtained from the theoretical considerations. The latest information on the subject is the paper read by Mr. Robert Hammond, at Manchester, before the Northern Society of Electrical Engineers. This paper, which we have been obliged to condense somewhat, must be considered as a distinctly practical one, as although the arrangement of the results has a tinge of an old theory in it, the facts are obtained from the engineers in charge of the machinery running in parallel. Returning for a moment to this old theory, that alternators can be classed according as to whether there is iron in the armature or not, the fallacious conclusion was that these factors determined whether or no there was self-induction in the armature. This, now, has been disproved again and again, as explained on page 94 of our issue of July 22, 1892. The self-induction of coils surrounded, as they must be, with iron can be just as high as those having iron cores. Answers obtained by Mr. Hammond, as at present divided, practically afford another proof of this fact. The whole question of the successful paralleling of alternate-current dynamos can preferably be divided as follows: firstly, the consideration of the curve of turning moments of the prime mover at different periods of the revolution; and, secondly, the corrective stresses set up by the alternator armature when the variation of the speed causes it to lead or lag behind the position of synchronism by a definite amount.

These are the fundamental considerations, and they can both be ascertained exactly if the design of engine and alternator are known. The even turning moment is of the highest importance, as evidenced by the failure of the attempt to use gas-engines, and also of some slow-speed steam-engines, for parallel working. Hence the prime movers may be classed as follows as regards their relative advantages for parallel working: turbines, three-crank engines with both a high and low pressure cylinder to each crank, similar two-crank engines, high-speed two-crank engines with high and low pressure pistons working on to separate cranks, and, finally, slow-speed engines of the same construction, and tandem engines. The chief fault with all but the first class of engine is the fact that the distribution of the load between the high-pressure and low-pressure cylinders varies so much with the load, and hence two differently loaded engines have widely different crank-effort diagrams. Then, coming to the alternators, the one most suitable for parallel running is that one in which a small deviation from the position of synchronism does not cause too violent corrective forces, but as the deviation increases these forces must increase. This effect is produced by self-induction, without which the running of the alternators would be as rigid as spur gearing, and at the expense of large synchronising currents. The author of the above paper concludes that

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flywheels are a great assistance to parallel work because of their influence on regular speed. On the contrary, although as a general rule the flywheel may be an advantage in certain cases, it is a distinct disadvantage, as proved at Derby. In fact, we would say that in most cases of the parallel working from slow-speed engines the parallel working is ensured by the excellent design of the alternator, in spite of the disadvantage of the engine. In conclusion, we would call attention to the following facts, which apparently some engineers do not know. When the average alternator is working loaded, a short-circuit in the mains will cause the engine to increase in speed. In this respect a short-circuit on an alternator is not so dangerous as one on a direct-current dynamo, as the short-circuit reduces the load. Also, that with a usual amount of self-induction in the armature, a temporary short-circuit will not harm the machine. This point, as a radical essential of alternator design, is carefully explained by Mr. E. Kolben in our issue of January 31.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRICITY A MODE OF MOTION.—THE RONTGEN RAYS. WHAT ARE THEY?

SIR,—It will be remembered that immediately on the receipt of the news of Prof. Röntgen's discovery, the writer claimed that the phenomena there described formed an additional proof that the theory of "What Electricity is" which he had formulated in the columns of the *Electrical Engineer* three years ago was correct. In his opinion the later information on the subject confirms the view he then took, though naturally modifying that view in points of detail.

Consider for a moment how the rays are produced and what their properties are, and their identity with the waves the writer believes to emanate from electrostatically-charged bodies will be apparent. Perhaps a point had better be mentioned here in connection with the matter of the identity of the rays. The writer's first view was that the Röntgen rays were merely electromagnetic waves, whose position in the physical scale he placed beyond the ultra-violet rays of the spectrum, their wave lengths being shorter and their rate of propagation faster than those of the ultra-violet waves. Subsequent study of the experiments that have been made on the Röntgen rays has led him to adopt the view that these rays are waves such as would emanate from an electrostatically-charged body, electrostatic waves, if the term be allowed, or simply electric waves. But he has also been led by a consideration of these experiments, and of those of Hertz and others, to doubt if there is really any difference between an electric wave such as would emanate from an electrostatically-charged body and the electromagnetic waves that we know emanate from a conductor in which electric currents are passing. Such differences as there are between the two forms of waves appear to the writer to be merely of degree, somewhat similar to the differences between the waves present in different parts of the spectrum, these differences being due principally to the difference in the E.M.F.'s ruling in the two cases.

The conditions necessary for the generation of the Röntgen rays appear to be the presence of a very high E.M.F., capable of giving a spark of not less than 2in. in air, and the opposition to this E.M.F. of an enormous resistance. Apparently an E.M.F. of not less than 100,000 volts is necessary where the Röntgen rays are formed, and a very much higher voltage unless a high rate of alternation or oscillation is also present. Apparently, the rays may be formed either on the *outside* of the glass of a vacuum tube that has been exhausted to a very high vacuum, something like $\frac{1}{1000000}$ of an atmosphere, or simply in the path of the brush discharge of an electrostatic induction machine having a sufficiently high E.M.F. The properties of the rays are: (1) The ability to pass through nearly all substances except metals, just as light rays pass through clear glass, and to pass through even some metals if only a thin plate of the metal is present; (2) the ability after passing through various substances that are insulators to electric currents, using the term in its popular sense, of performing the work done by the highly refrangible rays of the spectrum—that is to say, the ability to produce certain chemical changes in certain substances similar to those produced in the same substances by the actinic rays; (3) the ability to be converted actually into light rays when caused to impinge upon certain substances, such as platino-cyanide of barium, and this after passing through other bodies which are impervious to light; (4) the property of denoting the presence of metals in particular, and of other substances to a lesser degree, by the stoppage of the passage of the rays, and of the subsequent transformations, where these bodies lie in the path of the rays; (5) the ability to discharge electrified bodies, notwithstanding the fact that these bodies are carefully insulated.

But the ability to pass through all substances is a property that we well know to be common to all electrical discharges, no matter what form they take, providing the E.M.F. present is sufficiently high, and it is also a property now well known to exist with comparatively low E.M.F.'s, provided oscillations of very high frequency are present, as witness the vagaries of lightning and the startling effects obtained by Tesla, Elihu Thomson, Campbell Swinton, and others. It is a property with which every experimenter with high-tension apparatus is familiar, and is especially common to those apparatus in which alternate or oscillatory currents are present. The ability to stop or attract electrical discharges is also a property common to all electrical discharges more or less, but particularly to those in which high tensions are employed, as witness again the vagaries of lightning discharges and the experience of everyone who has handled an induction coil. The meaning of the apparent stoppage of the rays is not that metals and other bodies oppose their passage, but that they absorb the rays, screening objects beyond, just as a ring of iron screens a compass needle, and just as a metallic body screens objects behind it from heat rays emanating from a source in front. So, too, as the screening effect of the ring of iron for magnetism, and of the metallic body for heat, is only partially depending upon the mass of the screening body, the pressure ruling, and the specific capacity of the screening body for the particular form of energy it is warding off, so is the screening effect of metallic and other bodies from the Röntgen rays dependent upon their capacity to absorb these rays, their mass and form, and the pressure or force with which the rays impinge on them.

In (2) and (3) we have a similar conversion to that which takes place when an electric current generates heat, but owing to the very high E.M.F., the very high resistance, and the small space over which the action takes place, part of the electric waves pass at once into light waves, and proceed to perform the work that light waves do. The electric waves are retarded, and necessarily their wave lengths are shortened and their rates of vibration increased, just as in the case of an electric current passing in a conductor, but the conditions being different the results are naturally different. We have exactly the same thing happening in the vacuum tube, but in another way, and to a smaller degree. The discharge of insulated electrified bodies is evidently due also to the presence of the superior E.M.F. The waves, acting under the influence of the high pressure ruling, sweep through the conductor and its insulating envelope, the original charge joining with high-pressure stream of waves, and leaving the conductor discharged. The heat generated in the vacuum tubes is probably due to the mechanical bombardment of the molecules of the electrodes, which we know takes place

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under the high pressure ruling, but some will probably be due to direct conversion of the electric waves.

To sum up then. The writer submits that the Röntgen rays are electrical waves forced into space under very high tension, and that their action upon sensitive photographic plates is due to their conversion into light waves by the films themselves, upon which the action takes place; this conversion being due to the resistance offered by the films to the passage of the waves, just as the resistance of an electric conductor causes the conversion of a current passing through it into heat. Their ability to denote the presence of metals and other bodies is due to the capacity of those bodies, under the conditions ruling, for storing the electrical waves, and so screening those portions of the sensitive film that lie beyond.—Yours, etc., SYDNEY F. WALKER.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

March 13, 8 p.m.—Great George-street. Students' meeting. "Tests of Centrifugal Pumps," by J. C. Cornock (student).
March 17, 8 p.m.—At Great George-street. Ordinary meeting.

Institution of Electrical Engineers.

March 13 8 p m.—At the Library, 28, Victoria-street. Students' meeting (extra) Discussion on Mr. Fennell's paper on "Central-Station Experiences."
March 14.—Visit of Students to Messrs Siemens's Works at Charlton. Train leave Charing Cross at 10.20.
March 20, 8 p.m. —At the Library, 28, Victoria street. Students' meeting. "Some Distinctive Features of Continental Electrical Engineering Practice," by K. Edgcumbe and E. J. Fox (students).

Society of Arts.

March 18, 8 p.m.—At John-street, Adelphi, W.C. "The Bahamas Sisal Industry." by Dr. D. Morris, C M.G., M A.
March 19 8 30 p m.—At the Imperial Institute, South Kensington, "The Great Landslip at Gohna, in Gurhwal, and the Measures adopted to Prevent Serious Loss of Life," by J H Glass, C.I E., chief engineer, Department of Public Works, Bengal.

Physical Society.

March 13.—At Burlington House. Papers: (1) "An Addition to the Wheatstone Bridge for the Determination of Low Resistances," by Mr. J. H. Reeves; (2) "On Kathode Rays," by Herr Puluj.

King's College Engineering Society.

March 13, 4 p.m.—At King's College, London. Exhibition of lantern slides.
March 20.—"Gases as Illuminants," by Mr. Sodeau.

Royal Institution of Great Britain.

March 14, 3 p m.—At Albemarle-street, Piccadilly. "Light," by Lord Rayleigh, F.R.S. (fourth lecture).

Royal Astronomical Society.

March 13, 8 p.m.—At Burlington House. Meeting.

North-East Coast Institution of Engineers and Shipbuilders.

March 20.—At the Literary Society's Hall, Newcastle. Ordinary meeting.

PARALLELING OF ALTERNATORS.*

BY ROBERT HAMMOND, MEMBER.

Those of my audience to-night who had occasion to attend the Board of Trade enquiry in 1889, presided over by Major Marindin, and held to consider the applications for provisional orders by rival companies in the Metropolis, will remember that the opponents of the high-tension alternating system made much of the fact that it was impossible to run alternators in parallel, or, rather, that up to that time no practical method of doing so had been worked out. It is interesting in these days, when parallel running of alternators is almost universal, to peruse the expert evidence on the subject that was given during that enquiry. I do not intend to trouble you with that evidence in detail this evening, but I may now, however, summarise it by stating that while Dr. John Hopkinson, Mr. Alexander Siemens, and Mr. J. E. H. Gordon all held distinct opinions that such a plan of working was possible, all confessed that they were unaware of any works where it obtained. Lord Kelvin and Dr. J. A. Fleming gave evidence to the effect that there was no intention of working under these conditions at Deptford, while Mr. R. E. Crompton and Mr. James Swinburne, called in opposition to the alternating system, and aided by an expert from America, emphasised the fact that such a method of working had never been carried out in practice anywhere. On the other hand, it was taken for granted throughout that enquiry that it was absolutely necessary in an electricity supply works to run the "generators" in parallel in order to permit of changing over without the slightest flicker in the event of (*a*) a hot bearing, (*b*) a falling or rising load, thus making it possible to work each set of plant at its highest efficiency.

With regard to the proviso as to the necessity of avoiding the slightest flicker, the members of this society, imbued with the idea that an electricity works manager is unworthy of his position who deliberately plans a "blink or two" each evening, will, I am sure, recall with amusement, as well as astonishment, the calm way in which in the early eighties in the pioneer works the circuits were regularly each night at a certain hour completely cut out, pending the transfer of the work to the "light-load plant." I think it may be claimed that modern electricity works managers place absolute continuity of service—steady as a rock—above all other considerations, and I am sure that those among my audience who hold those positions will appreciate the weight of the objection raised to the alternating system as to its non-paralleling possibilities. If the doubts of the opposition had proved correct, and alternators could not be paralleled, it would be necessary, in order to avoid the slightest flicker, to work on the following lines: (1) the number of circuits and alternators to be identical; (2) each circuit fed by a separate alternator; (3) the maximum demand on each circuit never to exceed the maximum capacity of its corresponding alternator. Under this arrangement, each set of plant would be working most inefficiently at the time of low load, and the balancing of the circuits would be a constant source of worry to the engineer in charge of the ouside work. Altogether, it will, I think, be admitted that the mere statement of such an alternative would be sufficient to condemn the alternating system entirely, for it is evident that the works plant can only run at its highest efficiency by joining up the various circuits to one 'bus bar, or possibly to two, and throwing on one set of plant after the other as the load rises, reversing the operation as the load falls off.

To take an illustration from actual works. Last year the Madrid electricity works were equipped with nine 100-kilowatt sets, designed to give normally a current of 50 amperes at a pressure of 2,000 volts, each plant, however, capable on an emergency at the time of top load of giving 60 or even 65 amperes. There are nine circuits running from the works, and while inspecting the works there in October last I found that at one period of the run the demand was almost evenly distributed over the nine circuits thus:

Circuit.	Amperes.
No. 1	40
,, 2	33
,, 3	36
,, 4	38
,, 5	34
,, 6	35
,, 7	38
,, 8	30
,, 9	32
Total	316 amperes.

By feeding this from one 'bus bar six sets of plant were capable of coping with the load, while a seventh was running up for parallelling. The whole of the six sets were running at their point of maximum efficiency; whereas, on the one-circuit one-alternator plan, the nine plants would have all been running inefficiently. At the time of top load the advantages of parallel running became even more marked, for the output then took the form of—

Circuit.	Amperes.	
No. 1.	73	The normal capacity of each alternator being 50 amperes ×2,000 volts.
,, 2.	54	
,, 3.	59	
,, 4.	55	
,, 5.	64	
,, 6.	63	
,, 7.	68	
,, 8.	56	
,, 9.	58	
Total	550	

Here the total, through straining the capacity of the works to the utmost, was coped with by the nine alternators, but on the one-main one-alternator plan the extra demand on circuits Nos. 1 and 7 would have proved too much for the corresponding alternators. The dictum therefore laid down at the 1889 enquiry was, I think you will all agree, a correct one, and happily the confidence of the supporters of the alternating systems in the possibility of perfect paralleling has proved to have been amply justified.

I have alluded to the expert evidence that was given at the enquiry, wherein the experts one and all agreed that parallel running had not been carried out, and I think it is an evidence of the sturdy spirit animating electrical engineers that before

*Abstract of paper read before the Northern Society of Electrical Engineers.

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the enquiry closed, and in the short space of 10 days, Mr. W. M. Mordey announced his intention to read a paper on the subject before an early meeting of the Institution of Electrical Engineers, describing a series of satisfactory paralleling experiments which he had personally carried out with the Mordey alternators. Indeed, before the enquiry closed a surprise was afforded when, on almost the last day, Prof. George Forbes gave evidence of having the night previously witnessed the perfect paralleling of the Lowrie-Parker alternators laid down by me some months previously at the West Brompton works of the House-to-House Electric Light Supply Company.

Though parallel running had been described by Wilde in the *Philosophical Magazine* of January, 1869, and had been demonstrated experimentally by Dr. Hopkinson and Prof. Grylls Adams on the De Meriten's machines at the South Foreland in 1884, the running of the Lowrie-Parker alternators in regular work on the load at West Brompton was the pioneer of the present parallel running in our alternating-current high-tension electricity supply works. It may be of interest therefore to describe the method of paralleling that was then adopted which was thought out and applied by my then assistants, Mr. William Lowrie and Mr. Chas. Jas. Hall, and I give the following extract from a pamphlet descriptive of the works published in January, 1889: "For synchronising, previous to connecting two dynamos in parallel, an incandescent or glow lamp is provided beside the unit switch blocks; this is first switched in a circuit between and comprising a coil of each armature of the two alternating-current generating dynamo machines. When it is desired to couple together the said machines for supplying the circuits in parallel, the two machines are run as nearly as possible at the same speed, and when their phases synchronise (as indicated by the lamp) they are switched together by the plugging of the corresponding switch terminal base." Here it will be seen there is described exactly the method in vogue at almost all modern works. It is, however, not claimed that at the West Brompton works practical paralleling was carried out for the first time. That distinction, I think, belongs to the firm of Ganz and Co., whose representative—Mr. Otto T. Blathy—ran the alternators at the Rome works in parallel in May, 1888. The plant consisted of alternators driven independently each of its own engine.

Number.	Kilowatts.	Volts.	Amperes.	Revolutions.	Engine.
2	90	2,000	45	250	Sulzer.
2	320	2,000	160	125	Van der Kerchoven

On the evidence of Mr. Zipernowski, the adoption of this method of working was followed by the electricity works at Turin, Leghorn, Frankfort-on-Main, and Marienbad. In all these cases there was iron in the armature coils, causing, of course, a large amount of self-induction; and in Mr. Mordey's paper on "Alternate-Current Working," read before the Institution of Electrical Engineers on May 23, 1889, the author summed up the prevalent opinion at that period as follows: "alternators may be successfully run in parallel if they have a good deal of self-induction, and to secure this it is better that they should have iron-cored armatures"; whilst he announced himself prepared to to submit the view, "that a perfect alternator for any and every purpose should have no resistance and no self-induction." In order to support this bold contention, Mr. Mordey described a series of perfect paralleling trial runs of the Mordey alternator, but his deduction therefrom, in reference to the importance of the absence of self-induction, was strenuously combated by the highest authorities, and the controversy, transferred to the technical papers, raged for some months principally through the difficulty of suppressing Mr. Swinburne when once in circuit. Those interested in the mathematics of the subject would find it a plesant task, as I have recently found it, to re-read Mr. Mordey's paper and the controversy which it provoked.

My object this evening, however, is not to revive the sleeping Mordey *v.* Swinburne controversy, but to set before you the present position of parallel running in works in the United Kingdom using the alternating high-tension system. I cannot help feeling some amount of personal satisfaction that they are now so numerous. When Mr. Ferranti made a practical success of the system at the Grosvenor Gallery by running the transformers in parallel instead of in series I at once applied the system to our works at Eastbourne, where it proved so successful that I designed all my new work on the same basis. To establish the system many prejudices had to be overcome, and, as is usually the fate with pioneers, much personal monetary loss had to be encountered, but happily to-day the system is acknowledged everywhere, except in Manchester, to be the only one suitable for scattered areas, and the record total cost of production, 2·05d., is held by a company working on the alternating system—*i.e.*, that at Leeds—while the record works cost for works not having the assistance of public lighting is held by the same company—viz., 1·46d. The relative amounts invested in the various systems in the United Kingdom to-day are: in the Metropolis, low tension, £1,395,297; high-tension continuous, £129,850; high-tension alternating, £2,739,556 — total, £4,264,703. Outside the Metropolis, low tension, £1,647,776; high-tension continuous, £117,420; high-tension alternating, £1,885,340 — total, £3,650,536.

In order to enable me to lay before this society data as to the present practice with regard to paralleling, I have asked each of these works managers to kindly supply me with the following data. The queries were addressed to the following works managers, which I divide into: (*a*) Those who have kindly sent the data asked; (*b*) those who have replied that they do not run in parallel; (*c*) those who decline to give or refuse to allow data to be published under their names; (*d*) those who have not replied at all:

(*a*) Ayr, Altrincham, Bath, Blackpool, Bolton, Bournemouth, Bristol, Burton, Cardiff, Cheltenham, Coatbridge, Chelmsford, Derby, Deptford, Dover, Dublin, Eastbourne, Exeter, Halifax, Hanley, Hampstead, Huddersfield, Larne, Leeds, Portsmouth, Prescot, Southport, Kingston-on-Thames, Woking, Newport (Mon.), Woolwich, Salford, Tunbridge Wells, Worcester, Sheffield, Yarmouth.

(*b*) Bray, Cambridge, Newcastle and District, Scarborough, Taunton, Carlow, Coventry (not yet), Blackburn (not yet), Keswick, Reading (not yet), Sunderland (not yet).

(*c*) City of London, Newcastle-on-Tyne, West Brompton.

(*d*) Bedford, Ealing, Edinburgh, Lynmouth, Metropolitan Company.

I regret to be without data from the two companies having the largest alternating works in the kingdom. With regard to the Metropolitan Company, I believe I am right in stating that they do not run in parallel; and in reference to the City Company, the directors do not consider it advisable at the present stage to publish any data as to the working of their plant. Bearing in mind the distinction set up by Mr. Mordey, it is found that in these works, out of a total output of 11,401 kilowatts, the machines without iron in the armatures are in output just double of those with iron in the armatures. This result is largely contributed to by the 4,500 kilowatts in the Deptford works. The proportion of direct-driven and rope-driven plants is as follows: I. With iron in armature, direct driven, 1,381 kilowatts; rope driven, 3,820 kilowatts. II. Without iron in armature, direct driven, 7,368 kilowatts; rope driven, 3,820 kilowatts. The tendency, however, is strongly in favour of direct-driven slow-speed plants, and in considering the data that has been supplied special interest attaches to that from works where this type of plant has been recently introduced. [The answers to questions 1 to 7 are contained in the table at the end of the paper.—Ed. *E. E.*]

Question 8.—What would be the result if an idle alternator were accidentally connected to the active omnibus bar while the others were working and connected thereto?

With Iron in Armature.

Leeds.—(L. and L. and E. C. C.) This was done accidentally, and the dynamo was left in circuit for about one minute. The idle dynamo ammeter registered about twice its full output, but the dynamo was not damaged at all. It took its load shortly afterwards, and nothing was noticed to lead me to suppose that the machine was hurt in any way.

Newport.—(L. and L.) Have actually connected by mistake and switched off again without damage being done, although big load was put on the other machine at the moment. Fuses did not blow.

Woking.—(Mather and Platt.) Pyrotechnic display. The idle machine would, of course, be nearly a dead short between the bars.

Without Iron in Armature.

Coatbridge.—(Mordey.) The idle alternator would be speedily burned out if its main fuse failed to act.

Deptford.—(Ferranti). General and serious trouble all round. Lights out and probably damage to the running machines as well as to the standing one.

It would appear from the replies that the only places where this has occurred are Leeds and Newport, and in both these cases without ill effect. In all the other cases the answers state that the fuses would blow. From the tenor of the replies, however, I gather that the alternators with iron in the armature are deemed in this respect the more comfortable machines to have on hand. Somewhat akin to this point is that of a short-circuit on the mains during the parallel run, and I have taken some pains to discover the effect upon the alternators when they are of different inductance. This difference occurs most markedly in works like those of the City of London, where alternators without iron in the armatures are run in parallel with those containing iron. It also occurs in a lesser degree wherever machines of different types are in use.

It was once deemed very unsafe to run in parallel machines of widely differing inductances, and I remember the trepidation with which in the early days we ran in the works of the old Brighton company a Mordey in parallel with an E. C. C. alternator. I believe I am right in stating that when, four years ago, the City Company were very pressed for plant, having British Thomson-Houston machines at Wool Quay and Brush machines at Bankside, they tried, by way of experiment, the practicability of running in parallel through 1½ miles of

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cable two such dissimilar machines as the Thomson-Houston and the Brush, and succeeding to their great surprise in doing so, the engineers continued the arrangement for the whole of one winter There was a slight fluctuation always perceptible in the light, due, no doubt, to the difference in the wave curve given by the two machines. With regard to the effect of a short, my experience is that when alternators of different inductances are connected in parallel, and short-circuit occurs, the machines of least inductance suffer first. This, however, may hardly be looked upon as an argument in favour of highly inductive alternators, since it may be urged that in alternating, as in continuous, current systems the translating devices should be so arranged that short-circuits in the mains or network are not a controlling feature in determining armature reaction.

Question 9.—Will the alternators run short-circuited?

With Iron in Armature.

Dublin.—(E. C. C. and L. and L.) They would to a certain extent, until the fuses went or the engines slowed down. I don't advise this as a regular practice.

Eastbourne.—(E. C. C. and L. and L.) They have run with a short-circuit on the mains, and have burnt it out without damage to the coils.

Southport.—(Mather and Platt.) These alternators during their full-load test were short-circuited up to 80 amperes without doing the slightest damage.

Tunbridge Wells.—(Kapp.) I believe so, due to the enormous amount of self-induction.

Woolwich.—(E. C. C. and Swinburne.) Cannot say, as engines would not drive them.

Without Iron in Armature.

Cheltenham.—(Siemens.) I don't think it would harm any of our alternators to short-circuit them for a few minutes. The pressure would drop enormously and the engine pull up.

Chelmsford.—(Crompton-Brunton.) No. (Mordey.) Not as at present wound.

Worcester.—(Mordey.) Yes.

Question 10.—What exciting energy in real watts do the alternators approximately take at?

With Iron in Armature.

Altrincham.—(M. E. S.) Full load, 2 per cent.; no load, 1·6 per cent.

Ayr.—(Siemens.) Full load, 1·4 per cent.

Blackpool.—(E. C. C.) Full load, 3·0 per cent.; no load, 2·5 per cent. (L. and L.) Full load, 2·0 per cent.; no load, 1·5 per cent.

Halifax.—(E. C. C.) 100 kilowatts—full load 2·4 per cent., no load 2·0 per cent.; 50 kilowatts—full load 2 4 per cent., no load 1·0 per cent.

Leeds.—(L. and L.) Full load, 2·0 per cent.; no load, 1·51 per cent.

Salford.—(Hopkinson.) Full load, 1·0 per cent.; no load, 3·0 per cent.

Southport.—(Mather and Platt.) 50 kilowatts—full load 1·15 per cent., no load ·5 per cent.; 25 kilowatts—full load, 1·6 per cent., no load 1·2 per cent.

Without Iron in Armature.

Bath.—(Mordey.) 1,220 watts, full load.

Bolton.—(Mordey.) 1·8 per cent., full load.

Bristol.—(Siemens.) 2 per cent. at full load.

Coatbridge.—(Mordey.) 572 watts at no load; 825 watts at full load.

Deptford.—(Ferranti.) From 2½ to 3 per cent.

Prescot.—(Two Brush, two Ferranti.) Brush—no load 700, full load 1,000; Ferranti—no load 1,800, full load 3,000.

Sheffield.—(Ferranti.) Ferranti, 1·75 to 2½ per cent. Ferranti, 1·4 to 2·1 per cent.

Question 12.—Do you employ any resistance or similar device to facilitate parallelings?

With Iron in Armature.

All reply "No," except Bristol, and there only when paralleling the gas plant.

Without Iron in Armature.

All reply "No," except Larne, where they do.

The next question (11) in reference to the efficiency of the plant is one of great importance. The task of the electrical engineer being to transform mechanical into electrical energy, the measure of the commercial success turns largely upon the efficiency of the plant.

Question 11.—Have you made any efficiency tests of the plant? If so, what was the nature of the test and the result?

With Iron in Armature.

Dublin.—(E. C. C. and L. and L.) Efficiency of conversion from indicated horse-power to electrical horse-power, 75 per cent.

Leeds.—(E. C. C. and L. and L.) 70 per cent.

Newport.—(L. and L.) 71 per cent.

Salford.—(Hopkinson.) Electrical output to indicated horse-power, 84 per cent. Commercial efficiency, about 92 to 93 per cent.

Tunbridge Wells.—(Kapp.) Indicated horse-power to electrical horse-power test was made, resulting in 73·9 per cent.

Woolwich.—(E. C. C. and Swinburne.) 120-kilowatt machine, commercial efficiency full load, 94 per cent.; 40-kilowatt machine, commercial efficiency full load, 90 per cent.

The other stations had no results to give.

Without Iron in Armature.

Bath.—(Mordey.) 80 per cent.

Bristol.—(Siemens.) No tests taken since preliminary tests at manufacturers'.

Bournemouth.—(Mordey.) The only tests made have been from indicator diagrams as compared with output under working conditions. The $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ is about 80 per cent. at full load.

Deptford.—(Ferranti.) General works tests and comparisons between electrical output and indicated horse-power are made frequently, and show about 88 per cent. efficiency between engine and dynamo terminals.

Kingston-on-Thames.—(Siemens.) Efficiency of combined steam alternators: 25 kilowatts—full load 74·0 per cent., half load 68·8 per cent.; 50 kilowatts—full load 81·9 per cent., half load 74·6 per cent.; 100 kilowatts—full load 84·7 per cent., half load 77·2 per cent.

Prescot.—(Brush and Ferranti.) Brush plant engines and alternators 63 per cent. Full load, exclusive of exciting current, Ferranti plant, Browett-Lindley engine, and Ferranti alternators, 68 per cent. between steam-engine cylinder indicated and alternator terminals.

Sheffield.—(Brush and Ferranti.) Ferranti No. 1, commercial efficiency, 80 per cent. i.h.p.

Sunderland.—(Crompton-Brunton.) 73 per cent. ¼ load; 83·5 per cent. ½ load (from memory); 86 per cent. full load.

I regret that in forming this query I did not set out a basis of efficiency $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ or $\frac{\text{E.H.P.}}{\text{B.H.P.}}$, and I think I shall be tempted, when revising the paper for the *Transactions*, to trespass once more on the patience of my friends for this information. As the data now stands it is somewhat puzzling. I confess myself ignorant of the term "commercial efficiency." $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ I understand, and I gather that this works out:

Type I.—Dublin, 75 per cent.; Leeds, 70 per cent.; Newport, 71 per cent.: Salford, 84 per cent.; Tunbridge Wells, 73·9 per cent.

Type II.—Bath, 80 per cent.; Bournemouth, 80 per cent.; Deptford, 88 per cent.; Kingston, 84·7 per cent.; Prescot—Mordey 63 per cent., Ferranti 68 per cent.

These figures are most conflicting. I cannot understand how the first three percentages should differ, as the plant in the three places is almost identical. Several observations have convinced me that there is a difference of about 5 per cent. in the $\frac{\text{B.H.P.}}{\text{E.H.P.}}$ efficiency of the two types of plant. The commercial importance of this difference was illustrated lately by a negotiation in which I was recently concerned, where, with identically the same driving power, a copper disc machine was offered with a guarantee of 28½lb. of steam per kilowatt, as against 30lb. for an iron-armatured machine, the penalty fixed by me per pound being £100. High efficiency, however, ranks below safe, smooth working, and as the machine was intended to run in parallel, with iron-armatured alternators, I gave the preference to the type of the lower efficiency. I set out in this connection as a sort of *audi alteram partem* the record of burnt coils as far as it has been supplied to me.

Question 22.—Have any burnt coils occurred during 1895?

With Iron in Armature.

Altrincham.—(M. E. S.) At moment of paralleling one coil burst, but due to crack in ebonite insulation. During the parallel run none have failed.

Portsmouth.—(Ferranti and Parsons.) Once during the parallel run.

Without Iron in Armature.

Bournemouth.—(Mordey.) Burnt coils have occurred in alternators running singly and in parallel, but none at the moment of paralleling.

Hanley.—(Mordey.) Yes, but we do not care to publish particulars of any difficulties we may experience in running the plant.

Sheffield.—(Brush and Ferranti.) We have had coils burnt out at moment of paralleling, and during parallel run, and we have had them burnt out when the alternator was running singly. We have not lost any Ferranti coils yet.

Worcester.—(Mordey.) None at moment of paralleling. Occasionally during the parallel run, but none of them when running singly and on open circuit. No coils burnt out for five months.

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The rest say "No." The next question is a crucial one.

Question 13.—Do you run in parallel only for switching-over purposes? If not, do you run in parallel every night?

Question 14.—What is the length of the parallel run?

With Iron in Armature.

Altrincham, Ayr, Blackpool, Bristol, Burton, Dublin, Halifax, Leeds, Newport, Portsmouth, Salford, Southport, and Tunbridge Wells are worked in parallel regularly.

Eastbourne.—(E. C. C. and L. L.) For switching-over purposes only. A few seconds.

Woolwich.—(E. C. C. and Swinburne). The alternators are always put into parallel for changing over, and are occasionally worked together, more particularly the Swinburne machines. Any of them work perfectly in parallel with either of the others. We have sometimes worked in parallel for five to six hours. I see no reason why they should not work for any time required.

Woking.—(Mather and Platt.) We have run in parallel regularly every night when load was high and could not be equalised easily on two separate circuits. With only two machines to run in parallel I do not think it well to do so, if you can arrange your circuits to avoid it. It is useful for switching over when a lot of machines have to be gradually shut down, but with two machines there is only one momentary blink if switched over without synchronising.

Without Iron in Armature.

Bolton, Bristol, Bournemouth, Cardiff, Cheltenham, Deptford, Hanley, Huddersfield, Kingston-on-Thames, Prescot, Sheffield, and Worcester run in parallel regularly.

Chelmsford.—(Crompton-Brunton and Mordey.) Only run in parallel for switching purposes or when convenient.

Coatbridge.—(Mordey.) At present we run in parallel for switching-over purposes. Gas-engine big, too unsteady to admit of continuous parallel working.

Exeter.—(Mordey.) Have only run in parallel experimentally.

Hampstead.—(Siemens.) We run in parallel for switching-over purposes, and shall run regularly in parallel when the load is sufficiently great to warrant running two or more machines. Time taken to change over at present.

Hence it would appear that among works running machines of type I., parallel running is almost universal.

With regard to the non-paralleling at some of the plants using copper disc machines, Messrs. Ferrantis points out that the list does not include any works where their plant is in use, and possibly the cause may be one entirely outside the question of iron *versus* no iron in the armature.

(To be continued.)

LEYTON ELECTRIC LIGHTING.

The following letter as to lamps has been sent by Prof. H. Robinson, of 13, Victoria-street, Westminster, S.W., to the Leyton Urban District Council:

Gentlemen,—At the outset of the introduction of electric lighting into Leyton I am anxious to prevent worthless lamps being used, and this can best be effected by explaining the conditions that should be complied with in ordering lamps. To make the matter clear, I may explain that the great majority of incandescent electric lamps are at present worked at a pressure of 100 to 115 volts, and, as a general principle, the higher the pressure at which the lamps can be worked, the greater will be the economy in distributing the current, and the greater will be the facility of regulating the pressure over the district. This principle is universally recognised and has led to a movement during the last few years in the direction of adopting lamps to work at higher pressures. In response to this feeling, the Board of Trade has recently been advised to permit current to be supplied to consumers at 250 volts pressure, whereas previously the limit was 150 volts. Inasmuch as the higher voltage is the most economical from the suppliers' point of view, it is necessary from the consumer's point of view to adjust the pressure to meet his legitimate requirements, which practically means "what pressure will enable lamps of 8 c.p. or 10 c.p. to be employed." There is no difficulty in making lamps of 32 c.p. and upwards to work at 250 volts, and there are numbers of 16-c.p. lamps now working at 220 or 230 volts, but a difficulty arises with 8-c.p. or 10-c.p. lamps worked at 200 volts and upwards which does not arise when the pressure is only 150 volts. As the 8-c.p. or 10-c.p. lamps are largely used for private lighting and for business premises, the 150-volt pressure that has been adopted at Leyton will meet that demand, and at the same time it will utilise the mains to better advantage than if 100 volts pressure had been adopted. A pressure of 220 volts would have worked with greater economy from the suppliers' point of view, but the requirements of the consumers must not be disregarded either as a matter of policy or of fairness, and I am of opinion that you will find in Leyton that a happy mean has been adopted which will be advantageous to both interests. The electric arc lamp has a very much higher efficiency than the incandescent lamp, giving from three to eight times as much light per unit of electricity used. The arc lamp cannot, however, be made for small candle-powers such as are required for domestic purposes, but it is frequently adopted with advantage in shops and for lighting shop windows. The ordinary arc lamp works with a pressure of about 50 volts, and therefore three lamps can be worked "in series" with current supplied at 150 volts. The standard pressure of supply is fixed at a multiple of 50 in order to enable consumers to work arc lamps under the most favourable conditions. Thus, if anyone requires 300 c.p. or 400 c.p. or more, and can conveniently arrange for the light to be supplied at three points, the arc lamp can be adopted with advantage, and will cost less than any form of gaslight yet invented. I have been in communication with the leading firms of lamp manufacturers with a view to your obtaining the best incandescent lamps for the district and preventing worthless lamps being foisted upon consumers. Some of the makers prefer a single filament and some double filaments, and I advise your ordering both for the lamps that are required in the public buildings and also for the streets. This will give an opportunity to lampmakers to supply a first-class lamp, and it will assist the private consumers in regard to the adoption of a type of lamp that has been proved to have a good record.

COMPANIES' MEETINGS AND REPORTS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

The interim report to the shareholders for the half-year ended December 31, 1895, has been issued, as promised at the last annual meeting of the Company. The report says the works have been fully employed on central-station and other orders. No large contracts have been entered into, but the volume of smaller orders has been well maintained, and additional large contracts are in course of negotiation. The new type of direct-driven alternating plant has proved satisfactory, recent tests made by Prof. Kennedy and S. P. Thompson for the Dover Electricity Supply Company having yielded very good results, both as regards the economy and efficiency of the machinery supplied by the Company. A specially favourable feature to which attention is drawn is that the machines remain practically cold after a prolonged run at full load. Negotiations are proceeding for an amicable settlement of the Company's claim against the City of London Electric Lighting Company for plant supplied. The Company's Austrian and Australasian branches are showing improved results. The development of electric traction is being actively pushed forward, and important orders are anticipated from this source. The new high-speed engine designed by the Company's chief engineer has been fully developed and tested, and has given satisfactory results. Steps are now being taken to place it upon the market, and the directors anticipate a large sale of these engines for general application, as well as for electrical purposes. The Board are making efforts to institute and maintain economies in every department. With this object the policy of concentration at the works at Loughborough, Leicestershire, which has been referred to in several of the recent reports to the shareholders, is being consistently followed as opportunity arises, by expiration of leases or otherwise, for the disposal of the London premises. Though these economies will not make themselves fully felt during the present financial year, their ultimate result upon the administrative charges of the Company will be of a very substantial character. During the half-year the issue of £105,000 4½ per cent. redeemable second mortgage debenture stock, mentioned in the last report, has been offered to the shareholders and £76,770 has been allotted. The balance is held in reserve for issue at a premium when necessary, but the Company's funds are ample for all present requirements. The directors do not propose to declare an interim dividend, preferring to await the result of the complete financial year, which closes on June 30.

CITY OF BATH ELECTRIC LIGHTING AND ENGINEERING COMPANY, LIMITED.

Directors: T. O. Callender (chairman), Alfred Pitman, B. H. Van Tromp, C. J. Wharton, J. B. Wood, Ernest Pitman. Secretary: Wm. Jeffery. 2 Northumberland-buildings, Bath. Engineer and manager: G. F. Metzger, A.I.E.E.

Report of the directors and statement of accounts for the year ending December 31, 1895:

During 1895 the gross profit has amounted to £1,570. 8s. 3d., and at the same time a much more efficient service has been given to the consumers. After the payment of bank charges and mortgage and debenture interest, there remains a net profit of £1 131. 0s 3d. To this must be added the sum of £388. 0s 9d., balance of profit brought forward from 1894, giving a total of £1,519. 1s. This sum is sufficient to pay a 4 per cent. dividend on the ordinary share capital of the Company, and to carry forward about £150; but your directors consider it expedient to place this profit to a reserve account, after the payment of the directors' fees. The increase in the business of the Company during last year has been of the most substantial and gratifying character. The revenue from the sale of current and from installations, etc., has risen from £5,067 in 1894 to £6,152 in 1895, an increase of £1,085. An all-day and night supply of current has been kept up throughout the year, and the increase in the profit over 1894 has taken place notwithstanding this additional supply involves a

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serious loss throughout the summer months. The number of lamps connected is now 11,231, being an increase of 2,904 over the number installed at the end of 1894. The existing station plant is now well loaded, and directly the question of a provisional order is settled, your directors will consider the advisability of putting down plant for an additional 15,000 lamps, for which they believe there is ample demand. As in former years, all the expenses of keeping the plant in good condition have been charged against revenue. The running of the plant throughout the year has been most satisfactory, and it is now in the highest state of efficiency. In consequence of the opposition of the Bath Urban Sanitary Authority to the Company's application for a provisional order, a Board of Trade enquiry was held in Bath last March, with the result that the Board of Trade could not see its way to dispense with the consent of the local authority to the Company's order. Last November, this Company again gave notice of its intention to apply for a provisional order, and the local authority also made application for a provisional order, in almost similar terms. As the result of both these applications a meeting was held, at the invitation of the Board of Trade, between the Company and the authority, at Whitehall, on February 19, at which Sir Courtney Boyle proposed the appointment by the Board of Trade of an independent valuer to report to the Board of Trade on the value of the Company's property. Your directors at once agreed to this proposal, and they learn with pleasure that the Bath authorities have also concurred in it. They trust this independent valuation may prove useful in bringing the two parties to an agreement. Mr. B. H. Van Tromp is the retiring director and offers himself for re-election.

PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1895.

Dr.	£	s.	d.
Working expenses, including repairs and renewals of plant and machinery	3,693	0	3
Salaries of secretary, engineer, electrician, and other officers	787	9	0
Rent, rates, and taxes	180	18	1
Balance	1,570	8	3
	£6,236	15	7
Bank charges	191	8	6
Mortgage and debenture interest	247	19	6
Balance	1,131	0	3
	£1,570	8	3

Cr.	£	s.	d.
Proceeds of sale of current and installations	6,031	19	5
Sundry receipts	120	12	3
Stock—increased value	84	3	11
	£6,236	15	7
Balance gross profit	£1,570	8	3
Balance net profit	1,131	0	3
Balance from last account £563. 0s. 9d.; less directors' fees paid, £175	388	0	9
	£1,519	1	0

Dr. BALANCE-SHEET, DEC. 31, 1895.	£	s.	d.
3,384 ordinary shares of £10 each	33,840	0	0
50 deferred founders' shares of £100 each	5,000	0	0
Mortgages and debentures	5,700	0	0
Creditors—bankers, £3,628. 12s. 2d.;* other creditors, £1,630 6s. 1d.	5,258	18	3
Profit and loss account	1,519	1	0
	£51,317	19	3

* As security for this overdraft, debentures over the Company's property have been issued to and lodged with the bankers, and these are in addition to the £5,700 mentioned above.

Cr.	£	s.	d
Capital expenditure on works, plant, mains, construction, and sundries to December 31, 1894	41,087	9	7
Additions this year	1,784	6	6
	42,871	16	1
Goodwill	5,000	0	0
Debtors for current supplied and installations	2,504	17	4
Stock-in-trade	939	2	5
Cash in hand	2	3	5
	£51,317	19	3

BIRMINGHAM ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Henry Buckley (chairman), Geo. S. Albright, J. F. Albright, G. H. Johnstone, Francis W. V. Mitchell, J. C. Vaudrey (managing director).

Report of the directors submitted to the shareholders at the ordinary general meeting of the Company held at the offices of the Company, 14, Dale-end, Birmingham on 12th inst.:

The amount of net profit, including the balance of £1,001. 11s. 9d. brought forward from last year, is £6,570 11s. 8d. Out of this your directors recommend the payment of a dividend of 4 per cent., absorbing £3,629. 9s. 9d., placing £1,920. 9s. 11d. to the credit of the depreciation reserve fund, and a further sum of £250 to the general reserve fund, carrying forward the balance of £770. 12s. to next year's account. On making the above appropriation the total reserves and undivided profits will amount to £9,463. 18s. 6d. There has been a steady increase in the Company's business during the past year, the total number of 16-c p. lamps or their equivalent on order December 31, 1894, was 12,138, and on the same date in 1895 the number was 18,199. The additions since the close of the financial year have brought the number up to 19,401. The expenditure on capital account during the past year has been £50,537. 2s. 1d. Considerable additions have been made to the plant and machinery at the Dale End works. Included in the capital expenditure are the buildings and partial equipment of the Company's new stations at Edgbaston and Newhall street, as also the underground mains that have been laid through a considerable portion of the Company's new parliamentary areas. The directors are pleased to report that the two new stations are now in full working order. In the Edgbaston district the supply has been only available since October last, and the orders already received are encouraging. In the jewellers' district the demand for current, both for lighting and power purposes, considering the very few weeks the supply has been on the mains, is most satisfactory. The reduced scale of prices adopted by the Board last year has had the effect of increasing the number of consumers and augmenting the Company's business, and the slight falling off in the revenue caused by these reductions has now been overtaken, and justifies the policy adopted. The increase during the year in the use of motors has been considerable, and will no doubt in time become an important addition to the Company's resources. To cope with the output in the future, additional plant has been ordered for the equipment of the Dale End station, and generating plant is in hand for the Newhall-street depôt. As authorised by the shareholders at the last annual meeting, the registered capital of the Company has been increased from £100,000 to £200,000, and in October last 10,000 shares were issued at a premium of 5s. per share, and in accordance with the resolution passed at a special meeting of the shareholders the £2,500 received for the premium has been applied as follows: to writing off preliminary expenses, £1,685. 2s. 4d.; to writing off expenses incurred in the recent registration and issue of new capital, £154. 10s.; and the balance towards the reduction of the charge on account of the Company's provisional orders, £660. 7s. 8d. In accordance with the articles of association, two directors, Mr. H. Buckley and Mr. F. W. V. Mitchell, retire by rotation, and are eligible for re-election. The auditors, Messrs. Sharp, Parsons, and Co., also retire, and are eligible for re-election.

BALANCE SHEET, DEC. 31, 1895.

Dr. Capital and Liabilities.			£	s.	d.
Capital registered—viz., 40,000 shares at £5 each			200,000	0	0
Capital issued			150,000	0	0
Capital called up—viz.:					
20,000 shares, £5 per share			100,000	0	0
10,000 shares, £1 per share			10,000	0	0
30,000			110,000	0	0
Sundry creditors			22,176	11	4
Depreciation reserve fund, as at December 31, 1894	£5,112	8 11			
Add additions to date	1,920	9 11			
			7,032	18	10
General reserve	750	0 0			
Special reserve against provisional orders	660	7 8			
			1,410	7	8
Profit and loss account—Balance from December 31, 1894	1,001	11 9			
Profit one year to date	5,568	19 11			
	6,750	11 8			
Deduct amount applied to depreciation reserve	1,920	9 11			
			4,650	1	9
			£145,269	19	7

Cr. Property and Assets.			£	s.	d.
Land and buildings as at December 31, 1894			23,953	13	3
Add balance of further outlay to date			4,731	3	9
			28,684	17	0
Mains, machinery and plant, furniture and fittings, meters and electrical instruments, as at December 31, 1894	£57,649	5 3			
Add further outlay to date	45,753	8 4			
			103,402	13	7
			132,087	10	7
Cost of provisional orders to Dec. 31, 1894	3,974	14 8			
Add balance of cost on 1894 order	52	10 0			
			4,027	4	8
Cash in hand and with bankers			1,899	7	10
Sundry debtors (less reserve)			5,983	5	11
Stock of stores and work in progress as per signed stock-book			1,272	10	7
			£145,269	19	7

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Aberdeen.—The Corporation invite tenders for an additional engine of 300 h.p. at the electric lighting station.

Lima (Peru).—Tenders for the electric lighting of the city of Lima will be received up to June 1 next at the Peruvian Legation, Avenue Hoche 8, Paris.

Wallasey.—The Urban District Council want tenders by April 6 for alternators, concentric cables, and transformers. Particulars will be found in our advertisement columns.

Bedford.—The Electric Lighting Committee desire tenders by April 4 for a 240-h.p. compound engine and 150-unit alternator. Particulars are given in our advertisement columns.

Aston Manor (Warwickshire).—The Urban District Council require tenders for a high-speed vertical engine and dynamo for the improved lighting of the baths The estimate is £350.

Namur.—Tenders will be received on July 10 next for the construction of a telephone building at Namur. Plans and particulars can be obtained from le Service Téléphonique, Namur.

Duisburg (Germany).—The Municipality require tenders before March 23 for the electric lighting work for their new swimming-bath. Particulars can be obtained for 2 marks (2s.) from the Stadtbaurath, Duisburg.

Brussels.—Tenders are wanted for the supply of a large quantity of stores and fittings and apparatus (12 lots) for electric lighting. Specifications and particulars can be obtained at the Brussels Bourse, and tenders must be in by March 25.

Rotterdam.—Tenders are required by the Rotterdam Gas and Electricity Works for the supply of 75,000,000 kilogrammes of gas coal. Particulars for 10 cents (2d.) from Buch-händler Wed. P. van Weasberge en Zoon, Rotterdam. Tenders to be sent in by March 18.

Paris.—The supply of a telephonic switchboard for the office in the Rue Chaudron is open to tender. Application must be made by March 17 to the Direction générale des postes et des télégraphes, Rue de Grenelle 103, Paris, and tenders will be wanted by March 31.

Brunn (Austria).—The Municipality desire offers for the construction and working of a central station for the supply of electric energy for lighting the town, for power, and, if required, for running a tramway. Tenders must be sent before March 31 to the Bürgermeister, Brünn, Austria, from whom particulars can be obtained.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grange town, Yorkshire, to whom the plans, etc., must be sent by May 1.

Glasgow.—Tenders are required by the Corporation for a compound dynamo machine for the sewage purification works, Dalmarnock. Specifications and forms of tender may be had on application to Mr. Thomas Melvin, manager at the works, and tenders, properly sealed, and marked outside "Tender for Dynamo Machine," must be lodged with Mr. J. Lang, clerk, City Chambers, Glasgow, by 14th inst.

Aylesbury.—The Aylesbury Urban District Council invite tenders for lighting the several public lamps and the clock tower within the district of the Council for six months ending September 29. The conditions for lighting and all other particulars in connection therewith may be obtained on application to Mr. George Fell, clerk, Aylesbury, to whom tenders must be sent by 19th inst.

Altona.—Tenders are wanted by the Prussian State Railway Department for the supply of 93,000 arc light carbons and 16,000 incandescent lamps for direct and alternating currents during the year 1896-97. Tenders must be made upon official forms which, with the necessary particulars, can be obtained for 50pfg. (6d.) at the Centralbureau (Verwaltungsgebäude, Zimmer 67), der Königliche Eisenbahn Direktion, Altona.

Leeds.—The Electric Light Company invite tenders for the various works required in the extension of the electric light station in Aire-street, Leeds. Plans and specifications at the offices of the company, Aire-street, and bills of quantities on application to Messrs. Milnes and France, architects, 99, Swan-arcade, Bradford, until 19th inst., on which day sealed tenders, properly endorsed, are to be delivered to the architects by 6 p.m.

Paris.—The Direction générale des postes et des télégraphes, rue de Grenelle 103, Paris, require tenders for the supply of 10-millimetre and 16 millimetre paper tape for telegraphic instruments. Application for permission to tender must be made to the Direction by March 14, and tenders sent in by March 24. Tenders are also wanted for nine lots of apparatus for telegraphic offices. In this case application must be made by March 15, and tenders sent by March 25

Herne (Germany).—It is proposed to make a street railway nine kilometres (5½ miles) long from Herne to Recklinghausen, to be worked either by gas motors or electric traction. The undertaking will be put out to general competition, and the contractor will have to covenant for its completion in from one to five years. Tenders must be sent in by March 18, and particulars, price 1 mark (1s.), can be obtained from Herr Amtmann Schaefer, Der Vorwaltungsausschues, Herne.

Manchester.—The Manchester, Sheffield, and Lincolnshire Railway Company invite tenders for the supply, during twelve months ending April 30, 1897, of telegraph materials. Patterns can be seen on and after March 9, on application to Mr. A. W. Longden, storekeeper, at Junction-street Mills, off Ducie-street, London-road. Manchester; and specifications, with forms of tender may be obtained on and after same date, from Mr. Oliver S. Holt, secretary, London-road Station, Manchester. Applicants are requested to particularise the stores for which they wish to tender. Sealed tenders, endorsed "Tender for ——," to be in the hands of the secretary by 10 a.m. on March 17.

Chesterton (Cambs).—The Urban District Council is open to receive tenders for the public lighting of the district for seven years The tenders shall be made in the three following modes—namely, (*a*) lighting the district from August 14 to May 15 (inclusive) in each year; (*b*) lighting the district throughout the whole year commencing May 15 next; (*c*) lighting the district for either of the above periods (1) with ordinary burners, (2) with incandescent burners, if the illuminant with which the tender be made be gas. All cleaning, lighting, and maintenance to be done by the contractors Tenders to be sent to Mr James Spearing, clerk, 15, Sydney-street, Cambridge, by March 31.

Bradford.—The Corporation invite tenders for the following plant and machinery—viz.: (1) batteries: (2) surface condensing plant; (3) cables; (4) travelling crane; (5) steam and exhaust pipes. Forms of tender and specifications may be obtained on application to the electricity office, Town Hall, Bradford, on paying a deposit of £1 for each specification, which will be returned on receipt of a bona fide tender. Tenders, to be endorsed "Tender, Electricity Works," and addressed to the chairman of the Gas and Electricity Committee, and delivered at the town clerk's office, Bradford, by 25th inst. An assurance must be given by each contractor that he pays to the workmen employed by him not less than the minimum standard rate of wages.

Bangor.—The Corporation invite tenders for the construction, supply, and laying down of the necessary plant and mains for the supply of electricity in the borough The contract will be split up into two sections: (1) construction, supply, and erection of boilers (water-tube), steam-engines (double acting), steam and exhaust pipes, etc, economiser, feed pumps, condenser, alternators, exciters, accumulators, switchboard, travelling crane; (2) supply and laying down of mains and transformers. Specifications and plans may be obtained on payment of £2. 2s. for the former and £1. 1s. for the latter, which will not be returned, at the office of Mr F. Hastings Medhurst, M.I.E E., Westminster-chambers, 13, Victoria-street, S.W. The firm whose tender is accepted will be required to enter into a contract and a bond with two approved sureties for the due performance of the contract. Firms may tender for one or both sections, but tenders for a part only of either section will not receive consideration. Sealed tenders, endorsed "Electricity," to be delivered at the office of Mr. W. H. Pritchard, town clerk, Bangor, by March 18.

Bucharest.—The Communal Council require tenders for lighting the suburban districts of the city by some system which shall not require to be conveyed underground by means of pipes or otherwise, and which shall, in the opinion of the Board, be considered the most advantageous of all the systems submitted, with a view to substituting same for the 3,265 oil lamps now used for lighting the suburban streets and squares The contract shall be given in accordance with the specification relating thereto, which has been drawn up by order of the Board of Technical Works, and approved by the Communal Council at a meeting held on January 24 The specification may be inspected any day during business hours at the office of the Agence Havas, 96, Queen-street, Cheapside, London, E C. The contract to be given for a term of five years from April 1-13, on which date the present contract runs out. Sealed tenders will be received from the 14th to 26th inst. Applicants must, in their tenders, refer to the items provided in Article 6 of the specification. All persons desirous of tendering are requested to attend at the Mairie on the day and hour above mentioned and lodge security for 15,000fr., failing which they will not be allowed to tender. The tender to be governed by Articles 68-79 of the General State Accounts Act.

RESULTS OF TENDERS.

London, W.—The following tenders have been received for electric lighting, wiring, fittings, etc., in connection with the new St. Marylebone Public Baths and Wash-house:

F. A. Donnison and Co.	£2 050	0	0
F. Suter and Co.	1,950	5	4
H. South	1,950	0	0
Roger Dawson and Co.	1,681	3	7
Emanuel and Co.	1,666	0	0
Strode and Co.	1,633	10	5
L. Alwyn	1,422	0	0

Buckingham.—The Town Council have, on the recommendation of the Lighting Committee, accepted the supply of electric lamps on the same terms as last year.

Liverpool.—The tender of Messrs. Craven Bros., of Manchester, has been accepted for erecting an overhead travelling crane at the electric lighting station at Liverpool.

Keighley.—The Keighley and Bingley Joint Hospital Board have accepted the tender of the Keighley Electrical Engineering Company for fitting up the hospital buildings with telephones.

Bradford.—The Town Council have accepted the tender of Messrs. John Brown and Co, Limited, to supply and fix two steam boilers at the new electricity works at Valley-road, for £3,000.

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BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,777.

Great Northern Telegraph Company.—For the month of February the receipts were £22,000

Wells.—The Town Council have decided to apply for sanction to a loan for £10,000 for the installation of the electric light.

Westphalia.—It is intended to prohibit the firing of safety explosives in the coal mines otherwise than by means of an electric current.

Bingley (Yorks).—The Outer District Council have decided to request the National Telephone Company to place a telephone in the Council's office.

Buckingham.—The Town Council have decided to accept the supply of electric lamps from Messrs. Gillies and Hornidge on the same terms as last year.

Bengal.—A scheme for lighting Belvedere, the official residence of the Lieutenant-Governor of Bengal by electricity has received the sanction of Government.

Thornhill (Yorks).—The Urban District Council have decided to have the house of the waterworks inspector connected by telephone in case of emergency.

Leeds.—The Highways Committee have decided to proceed with the laying of the electric traction from the Canal Gardens to Kirkstall with the least possible delay.

Canterbury.—The Electric Light Committee have before them the report of the engineer on the introduction of electric light to the city at an initial cost of about £14,000.

Chelmsford.—The Essex Standing Joint Committee have decided to construct telephonic communication between the shire hall and the house occupied by the police sergeant at Widford.

Newcastle-on-Tyne—The Town Improvements Committee do not recommend the Council to carry out the doubling of the single lines of the tramways authorised by the Act of 1892.

St. Helens.—The Gas and Lighting Committee of the Corporation have decided to accept the tender of Mr. W. Molyneux, of Parr, for the erection of the new electric lighting works.

Southport.—At the monthly meeting of the District Highway Board Mr. Orritt presented a detailed plan of the positions of the proposed telephone posts at Formby, which was approved.

Monifieth (Forfarshire).—The Police Commission have resolved to hold a public meeting on an early date to consider the whole matter of lighting, either by gas, electric light, or other illuminant.

Wolverhampton.—The Lighting Committee's estimate for lighting, etc., street lamps is £159 in excess of last year. Provision is made for the increase in the number of electric lamps from 42 to 51.

Weybridge—A communication has been received by the Urban Council from the Board of Trade announcing the fact that the order of the Weybridge Electric Supply Company had been revoked.

Wakefield.—At the meeting of the City Council a discussion ensued on the proposed electric lighting works, and Alderman Sherwood said the committee hoped shortly to commence building operations.

Minster (Kent).—At a meeting of the Guardians Dr. Flint enquired if anything was being done in regard to the question of electric light. Mr. West replied that the committee were making enquiries in the matter.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending March 8 amounted to £1,040, as compared with £937 in the corresponding week of the previous year, being an increase of £103.

Halstead (Essex).—At the Urban District Council meeting the surveyor reported that Messrs. Crompton had sent one of their engineers to Halstead on February 20 and he had inspected the town, but his report had not yet been received.

Kingswood.—At the meeting of the Urban District Council a letter was read from Messrs Lawrence and Co., solicitors to the Council, stating that the provisional order for the electric lighting of the suburbs of Bristol would not be proceeded with.

Electric Lighting of Railway Carriages.—The new electrically-lighted carriages on the Great North of Scotland Railway have made their first journey to Elgin. During the whole journey from Aberdeen, the electric light remained steady and no hitch occurred.

Eastbourne.—The balance sheet of the Eastbourne Electric Light Company, Limited, shows a gross profit of £3,182. 2s. on the year. A dividend will be paid of £7. 10s. per annum, free of income tax, and £557. 5s. will be carried forward to next year's account.

Longton—The Town Council have given their consent to the provisional order of the North Staffordshire Tramways Company, and have appointed a sub-committee to consider the offer of the tramways company to work the existing lines in the borough and report thereon.

Nottingham.—The recommendation of the Electric Lighting Committee to expend £40,000 in the extension of the electric light works having been agreed to, application is being made by the Town Council to the Local Government Board to sanction the raising of the additional capital.

Garston (Lancs.).—The Urban Council have decided to ask the promoters of the Electric Lighting Bill for the district whether they would be willing to reduce the maximum price to 8d., the same as in Liverpool, and, further, within two years to supply any part of the district when requested by the Council.

Kidderminster and Stourport Electric Tramway.—The Great Western Railway Company have deposited in the private bill office of the House of Commons a petition praying to be heard by counsel against this Bill when the committee stage is reached. The Bill has been read a second time in the House of Commons.

Direct Spanish Telegraph Company, Limited.—The Board have decided, subject to audit, to recommend the payment of a dividend of 10 per cent. per annum on the preference shares and a dividend, free of income tax, at the rate of 4 per cent. per annum on the ordinary shares, both for the half-year ended December 31, 1895.

Belfast.—There has been some amount of correspondence in the local Press on the subject of the tramway service. Mechanical traction is desired, and the electric overhead system has been suggested. The deputation which visited Continental and English towns where electric traction is in use has returned and will report shortly.

New Book.—Under the title of "Future Trade in the Far East," Messrs. Whittaker have in the press for production early in the current month, a book by Mr. C C Wakefield, F.R.G.S., which will deal solely with commercial matters in China and Japan; particular attention being given to the Trans Siberian Railway now in progress.

Temperary Installation.—For the occasion of the annual assault-at-arms of the London Scottish Rifle Volunteers this (Friday) evening, a temporary installation of the electric light has been put in at the headquarters, James-street, Buckingham-gate, S.W., by Messrs. Lovelock, Seabourne, and Lee, Mare-street, Hackney.

City and South London Railway.—The returns for the week ended March 8 were £977, compared with £971 for the corresponding period of last year, being an increase of £6. The total receipts for the half-year terminating as above were £9,837, compared with £9,911 in the same period of the preceding year, being a decrease of £74.

Hull.—The Finance Committee have received a letter from the Local Government Board declining an extension of the period for the repayment of a loan of £8,000 for electric lighting purposes sanctioned in November last. It was explained that the loan was for machinery, and that in refusing the application the Board was carrying out its usual practice.

The Colonial Lighting Syndicate.—This syndicate has been formed with a capital of £2,000 divided into 40 shares of £50 each, to contract for the acquisition in Australia, New Zealand, Tasmania, or any islands or countries near thereto, gasworks and gas undertakings, and to contract for the supply of gas, electric, or other artificial light in these countries.

Goole.—The Aire and Calder Navigation Undertakers intend to introduce a system of electric lighting on their dock property at Goole. Hitherto the quays have been illuminated by gas supplied from the works which have been owned respectively by the Aire and Calder Navigation, the Goole Gas and Water Company, Limited, and at present by the Urban District Council.

Bury St. Edmunds—At the Town Council meeting, the Electric Lighting Committee reported that Mr. Medhurst's report on his scheme for lighting the town by electricity had been discussed, and enquiries were made of him on various points connected with the scheme. It was resolved that Mr. Medhurst be asked for a further report and supplementary estimate.

Mevagissey (Cornwall)—It is proposed to celebrate the inauguration of the electric light in the streets, and a committee has been appointed to confer with the Parish Council with reference to the suggested demonstration. It is expected that the streets will be lighted by the 24th inst., and Mr. Headley, of the electric works, has promised an electrical exhibition and a lecture on "Electricity."

Foxfield (Lancs.).—There is a proposal to construct a light railway through the Duddon Valley, and it is stated that electric traction on the overhead wire system could be very cheaply worked, because there is a sufficient fall of water from Seathwaite Tarn to supply all the energy that would be required to run electric cars. Besides, the valley would lend itself to a gradual gradient from Seathwaite to Foxfield.

Marylebone (London).—The Vestry have resolved, on the motion of Mr. Brooke Hitching, chairman of the Electric Light Committee, to substitute arc lamps for the gas lamps in Upper Regent-street from Oxford-circus to the Langham Hotel. The cost of these lamps will be £180 per annum, and they will give a light of 6,000 c.p. At present £150 per annum is paid for the gas lamps, which yield but 850 c.p.

Chesterton (Cambs).—The clerk to the Urban District Council has received a letter from the Cambridge Electric Lighting Company, stating that the company had carefully looked into the question of their powers, and had found that they were not empowered to light beyond the municipal boundary of Cambridge. They, therefore, regretted their inability to tender for the public lighting of the Chesterton district.

Chester.—At the Town Council meeting the Mayor, as chairman of the Electric Lighting Committee, said the estimate for the machinery and the dynamos had been increased on the recommendation of Prof. Kennedy by about £1,400, making the total amount for the machinery and plant about £15,600. The total amount for the electric lighting, including the additional £6,000 over the original estimates, would now be within £22,000.

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Ilfracombe.—At a meeting of the District Council a letter was received from the National Telephone Company asking whether the Council would agree to join the exchange. This was deferred for future consideration. An application by the same company for permission to erect poles on the Lee-road was made, and the clerk was directed to say that many of the roads were so narrow that the company should apply to the landowners adjoining.

Bristol.—At a special meeting of the St. George Urban Council a deputation was received from the tramway company in response to the chairman's motion, "To petition the Bristol Tramway Company in favour of their fares on the electric tramway being altered from 4d. to 3d. fares." After a brief discussion Mr Butler announced that the company would accede to the request, which should come into operation as soon as the new tickets, etc , could be prepared.

Dudley.—At a meeting of the Town Council Councillor Hughes remarked that there had been a change in the directorate of the gas company, and they might get some concessions. If not. they might consult with electrical engineers to light the town with electricity. He was a shareholder in the gas company, but he agreed that the price charged for gas was higher than it should be It was ultimately decided to refer the matter to the Streets and Gas Committee.

Bromley —At a meeting of the Urban District Council a letter was read from Messrs. Waterer and Dickens in regard to the proposed electric lighting syndicate, stating that the letter from the Council was so out of keeping with the views expressed by the committee who interviewed the delegates that they were surprised. Their clients would not meet again for some little time, and they hoped the Council would still consider them in treaty for the acquisition of the provisional order.

West Bromwich.—The correspondence relative to the South Staffordshire Tramways Company and their communication with the Board of Trade making formal application for an extension for the use of steam on their lines has been submitted to the Town Council. It was embodied in the report of the Highway Committee, who added that a letter had been received by them from the local tradesmen's association, advocating the cable system and protesting against the electric overhead wires.

Haslingden —At a meeting of the Town Council it was moved by Councillor Bentley, seconded by Councillor Barlow, and resolved that the town clerk take the necessary steps to obtain the provisional order under the Electric Lighting Act. It was further moved by Councillor Baxter, seconded by Alderman Barlow, and resolved that Alderman Holt and Collinge and Councillor Bentley be appointed to confer with the town clerk, and obtain all necessary information in connection with such proposed provisional order.

Bell's Asbestos Company.—The report of Bell's Asbestos Company for 1895, to be laid before the general meeting in London on March 19, states that the result of the year's operations is a net profit of £3,207, to which has to be added £3,593 brought forward, making a total of £6,800. After placing to reserve fund £1 000, there is left for appropriation £5,800. The directors recommend the payment of a dividend at the rate of 3 per cent. per annum, free of income tax, and the carrying forward of £2,200.

Lambeth (London) —The Ratepayers' Association at their last meeting congratulated themselves on the Vestry having handed over the electric lighting order to a private company, and so rid themselves of a costly experiment. One gentleman, however, moved a vote of censure on those vestrymen who had voted for handing the electric light over to a private company. He thought Lambeth should have gladly seized the opportunity of striking a blow at monopolies, but he only got two members of the meeting to support him.

Edinburgh.—The Electric Light Committee of the Town Council have had under consideration the appointment of an electrical engineer in room of Mr. Monkhouse, who has resigned. There were over 70 applications for the post, and from these Prof. Kennedy has made a selection of six. The committee unanimously recommended the Council to ask Prof. Kennedy to become a permanent official of the Corporation, and as chief engineer to advise upon all points in connection with the installation. His salary will be £200 a year.

Worcester.—At a meeting of the City Council, Alderman Williamson proposed that the accounts of the electricity department for 1895 which had been published be approved and forwarded to the Board of Trade. He said he thought the Council must have been agreeably surprised to find that they had not sustained the heavy loss which they had been led by some members of the Council to believe they were sustaining, and that the amount which had been expended was not so much as many members thought. The motion was carried.

Burslem.—The Council have unanimously confirmed resolutions of the Tramways Committee authorising the town clerk to lodge with the Board of Trade the formal consent of the Corporation to the provisional order of the Potteries Extension Tramways, and directing the corporate seal to be affixed to an amended agreement with the promoters of the extension tramways, and to an agreement with the North Staffordshire Tramways Company that the power of the Town Council to purchase the company's undertaking be postponed for 21 years from August 1 next.

Belfast.—Mr. V. A. H. M'Cowen, engineer, attended at the last meeting of the Electric Committee, and was heartily congratulated on his recovery from his recent severe illness. He submitted tenders for the supply and erection of a compressed-air engine starter, and that of Messrs. Kerr, Stuart, and Co. was accepted. A letter was read from the Board of Trade with copy of the new regulations made by the Board under the Electric Lighting Acts, 1882 and 1888, and the engineer was instructed to report as to these regulations as affecting the Corporation.

Vacancy.—The Uganda Railway Committee are in want of an officer to take charge of the erection and working of telegraphs. The salary is £400 a year, and applications should be made by letter only, and with copies of testimonials, to the secretary, Uganda Railway Committee, Foreign Office, Whitehall, London, S.W. No one need apply who cannot produce certificates showing that he has received a good general and professional education, the latter including the science as well as the practical part of his profession, and the applicant's age must not be less than 25 or more than 40 years.

Bridgend.—At the meeting of the Urban District Council a let er was read from Mr. J. C. Howell, Llanelly, in which he stated he was prepared to pay an amount equivalent to that which the Council had expended in obtaining the order for electric lighting, and would also proceed to put down the necessary plant, etc., for carrying out the undertaking. He would also give the Council the option of purchasing the undertaking after a certain interval on payment to him of the preceding years' profits. After a short discussion it was agreed that the letter be considered at a special meeting of the Council.

Portsmouth.—The balance-sheet of the Electric Lighting Committee for the year 1895 shows an excess of income over expenditure of £2,463 14s. 6d. In the case of a private company this would have enabled the directors to pay a dividend of 3¾ per cent., but as the committee have to pay off, in annual instalments of principal and interest, the money borrowed for the works, they are setting aside the year's profit for that purpose. This balance-sheet was prepared expressly for the Board of Trade. The one to be presented to the Council in April will be far more favourable, as the results of the working during this year are increasingly satisfactory.

Harrogate.—At the meeting of the Town Council it was stated by the town clerk (Mr. W. H. Wyles) that the Board of Trade had provisionally approved of the Harrogate Electric Lighting Order, 1891. A letter was read from the Local Government Board intimating that they could only sanction a loan of £27,000 for electric lighting on condition that the Council adopted the rules and regulations of the Board of Trade. The matter was referred to the Electric Lighting Committee. It was reported that the houses of the fire brigade have been connected with the station by telephone, and other steps taken to protect the town against fire.

London Lighting Extensions.—The County Council have given sanction to the following applications: From the House-to-House Electric Light Supply Company to lay low-tension mains in Thistle grove-lane, and high and low tension mains in Fulham-road, Warwick-road, and Earl's Court-square; from the Notting Hill Electric Lighting Company, to lay mains and to construct street boxes in Holland Park; from the Kensington and Knightsbridge Electric Lighting Company, to lay mains in Prince Consort-road and across Princes-gate; and from the Charing Cross and Strand Electricity Supply Corporation, to lay mains along Harvey's-buildings from a street box in the Strand.

Altrincham.—At a meeting of the Urban Council, Mr. J. Drinkwater moved the adoption of the minutes of a special meeting of the Highway and Lighting Committee. He said there was first the agreement which had been entered into by the Altrincham Electric Supply, Limited, with Ashton-on Mersey for the lighting of the township. The agreement was an excellent one, and if at any time Altrincham should wish to purchase the electric plant it would not be under any circumstances in any way bound by the agreement It was also resolved to write the Board of Trade and to inform them of the satisfactory arrangement made with the company. The minutes were adopted.

Coventry.—In the case of Jackson *v.* the Coventry Electrical Engineering Company, Mr. Justice North has had before him a motion in a debenture holders' action for the appointment of a receiver and manager of the assets of the company. Mr. Whinney said that the company appeared by Mr. Kenyon Parker, and consented to the motion. Mr. Justice North made the usual order in a debenture holders' action, and appointed Mr. Pearson receiver and manager by the same order, to act at once. Mr. Kenyon Parker mentioned that the plaintiffs held £200 of £800 debentures, and that there were current contracts pending, and considerable plant to the value of about £1,000. It was directed that Mr. Pearson's security should be completed forthwith.

Aston Manor (Warwickshire).—Owing to the inefficient and unsatisfactory character of the electric lighting plant erected at the baths three years ago, the Council have decided to duplicate the plant, and for that purpose have instructed their surveyor (Mr. H. Richardson) to obtain tenders for a high-speed vertical engine and dynamo. The estimated cost is £350, and application is to be made to the Local Government Board for sanction to a loan for that amount. The surveyor has also been instructed to have the telephonic communication altered at the Council offices by connecting each office, as well as the lines from the baths, hospital, fire station, and interception department, to one switchboard in the caretaker's department. The estimated cost is £50.

Plymouth.—The Electric Lighting and Municipal Offices Committees received 40 applications for the post of electrical engineer. After going through the testimonials they reduced the number of candidates to five, and appointed a sub-committee to visit the towns in which those candidates resided and make personal enquiries. As the result the joint committees unanimously recommended the appointment of Mr. J. H. Rider, of Bolton. Mr. Rider was 33 years of age, and had designed, supervised the

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construction, and now had the sole management of the electric lighting installation in Bolton. At the meeting of the Council to which Mr. Rider was introduced, Mr. Radford moved his appointment, remarking that both committees were unanimous in the belief that they had found in him the best man for the position. Mr. J. Willoughby seconded the proposition, and it was carried.

Harrington (Cumberland).—At the meeting of the District Council Mr. Curwen moved that the question of the lighting of the district by electricity be considered. He would not speak at length on the matter, but proposed that they appoint a committee to obtain information as to the expense of lighting the district by electricity and report to the Council. It was the general opinion that electricity was the light of the future, and it would be a great benefit if it could be introduced at a reasonable expense. Mr. Thom seconded the motion. Mr. Rutherford did not think they could do anything in regard to electric lighting. He did not see why they should put more work on the surveyor, when there was no prospect of anything being done He proposed that the question of electric lighting be left out altogether. Mr. Johnston seconded. On a vote being taken, Mr. Curwen's motion was carried.

Hanley—At the meeting of the Town Council, the General Purposes Committee recommended that from and after January 1 last charges for electrical energy be made as follows: 5d. per unit to general consumers; 4d. per unit for churches, chapels, and other places requiring light principally on Sunday evenings; 3d. per unit for energy supplied for motive power; and that, in lieu of the discount of 5 per cent. hitherto allowed, an abatement of ½d. per unit be made on all accounts paid within 21 days from the end of the quarter. Mr. A. Wood, in moving that the recommendation be confirmed, said that these reduced charges would mean a loss of £511, to make up for which they would require additional current to the extent of 35,000 units. The recommendation of the committee was confirmed, with the exception that the discount was fixed at 5 per cent., instead of ½d. per unit.

Colchester.—The Electric Light Works Committee unanimously recommended the Council to appoint the mayor a member of the committee, and at the meeting of the Town Council Mr. Barritt moved the adoption of the report. Mr. Goody seconded, and the motion was unanimously carried. The Town Clerk said a letter had been received from the officer commanding Royal Engineers stating that he was directed by the Secretary of State to say that the War Department would be prepared to have the electric light for the blocks of officers' quarters and mess and the recreation establishment in the new barracks if the current could be supplied at a rate which should be satisfactory to the Secretary of State, but the question of lighting the whole of the new barracks must await the result of experiments being made elsewhere as to the suitability of such light for general barrack purposes. The letter was referred to the committee.

Hove (Brighton).—The annual meeting of the electric lighting company was held last week at Cannon-street Hotel, London, Colonel Filgate presiding. In moving the adoption of the report, a copy of which has appeared in a previous issue of this journal, the Chairman stated that the revenue from the sale of current had increased from £3,616 in 1894 to £5,343 in 1895. The number of lamps attached to the company's mains numbered 18,403 of 8 c.p., while the consumers were 270. The consumption of electricity was still increasing in their district, and the estimated net revenue for January and February of this year showed an increase of about 25 per cent. over that in the corresponding period of last year. The Board had decided to pay off the 5 per cent. debentures and to issue others bearing 4 per cent. Colonel Wood seconded the resolution, which was adopted A dividend at the rate of 4 per cent. per annum was afterwards declared.

Oxford.—There is an increase according to the Finance Committee's estimate of £272 in the amount required for lighting. There are already 32 arc lamps of 2,000 power in working order. The new municipal buildings are being installed with the electric light The dividend recommended by the directors of the Electric Company at the fifth ordinary general meeting of shareholders is 3½ per cent. on the ordinary shares; there has been a gross profit on the year of £2,709. 8s. 3d, and after providing for the full interest of 5 per cent. on the debenture issue and other interest there remained £1,317. 9s. 4d., which added to the amount brought forward from the previous year, £195. 4s. 8d., left an available balance of £1,512. 15s. The sum of £360. 3s. will be carried forward to the next account. To provide for extensions of the system, in consequence of the anticipated increase in the demand for current, the directors propose to issue 914 ordinary shares of £5 each.

Ayr.—At the meeting of the Town Council a long report was submitted by Mr. Hammond, the electrical engineer, in which it was stated that with the exception of the transformers the plant was in good order. With reference to the transformers which had proved defective, Mr. Hammond pointed out that in terms of the conditions of the contract the Corporation were entitled to reject them. It appeared that new contracts for efficient transformers had been entered into with Messrs. John Fowler and Co. It was agreed, on the motion of Mr Grant, that Mr. Hammond should be requested to furnish a supplementary report with regard to the temperature test of the defective transformers at the works of the contractors before delivery. It was intimated that Messrs. Callender and Co. had expressed their willingness to guarantee their cables for five years, and the Council agreed to accept the guarantee. It was agreed to apply to the Secretary for Scotland for power to borrow a further sum of £5,000 for the electric light.

Helensburgh.—The question of street-lighting has been discussed by the Police Commissioners. Mr. Bryden thought that, instead of extending the present antiquated system, the committee should rather be empowered to consider the lighting of the town with the electric light. The town lent itself naturally to that system, and they had a splendid water power. Bailie Duncan said they had already consulted an electrical engineer on the subject, and he rather discouraged it. The electric light cost three times as much as gas. The Provost thought the electric lighting of the town could be effected. He alluded to the case of Cape Town, which was lighted by water power, and the water afterwards used for domestic purposes. He had consulted an eminent gentleman in Glasgow on the subject, and he believed such a system would be practicable in Helensburgh at a small expense. When he had received more complete details he intended to lay the matter before the people. Mr Bryden's suggestion was agreed to.

Commercial Cable Company.—The report of the Commercial Cable Company for 1895 states that the gross earnings amounted to 2,009,738dol., and the working and other expenses to 794,340dol., leaving a balance of 1,215,398dol There was an increase in the earnings of 236,304dol., and an increase in expenses of 31,345dol, as compared with the returns of the previous year, resulting in an increase in net earnings of 204 959dol. Dividends of 1¾ per cent for the quarters ending March 31, June 30, September 30, and December 31 have been paid; a total of 7 per cent. for the year on the capital stock, amounting to 700 000dol. The reserve fund has been augmented by the purchase of 200 000.00dol United States Government bonds The balance of the year's profit, amounting to 315,398dol., remains to the credit of profit and loss. Six sections of the cables were interrupted at different periods during the year, chiefly caused by contact with anchors of fishing vessels. The repairs were, however, promptly effected. The whole system is in excellent condition.

Stafford.—At a meeting of the Town Council the Gas and Electricity Committee recommended that the electric cables be extended along Lichfield-road to St Paul's Church at a cost not exceeding £250, and that the two ¼in. feeders be extended from Tipping-street to Dr. Cookson's, in Lichfield-road, at a cost not exceeding £200. The engineer having conferred with the sub-committee of the County Council on the subject, the committee asked for sanction to an agreement with the County Council for the lighting of the County Council buildings, the Judges' House, and Eastgate House with electricity, a minimum charge of £43. 15s. per quarter to be made, with a further charge of 8d. per Board of Trade unit for all current consumed over 1,312 units per quarter, the number of lamps not to exceed 1,200 8 c.p. or their equivalent. These terms to be subject to revision at the end of 12 months. In moving the adoption of the report, Alderman W. H Peach said more revenue had been expected from the supply of electricity to the County Council buildings, but the terms were subject to revision at the end of 12 months. Alderman Silvester seconded the motion, which was agreed to.

Islington (London).—A description of the Islington electric light station appeared in our last issue, but the following particulars in reference to the boilers may be added. The mountings and valves of these are throughout the manufacture of J. Hopkinson and Co., Limited, Huddersfield. Each boiler is equipped with a patent "Duad" safety-valve for high steam and low water; a duplex safety-valve for high steam; a patent parallel slide-valve to steam-main; a patent steam-isolating valve; two accessible check-feed valves; a patent parallel slide blow-off valve with locking gland; an isolating blow-off valve; two sets of patent "Absolute" water gauges with safety shields; and one 10in steam gauge, with asbestos-packed cock, and syphon with connection for indicator or test gauge. The valves on the steam main feed pipes, pump-main, and exhaust-pipes are throughout Hopkinson's parallel slide-valves. We also omitted to state in our necessarily short description of the buildings that the whole of the skylights are glazed on the Rendle "Invincible" system. The effective nature of the lighting is at once noticed on entering the engine and boiler rooms. Skylights glazed in this way are practically indestructible.

Audenshaw—At the District Council meeting the Clerk observed that already the Council had given their approval to the Manchester Tramway Company's scheme, which proposed to do more than the Electric Tramway Company. The Chairman said that the Manchester company proposed to cover the whole of the road which the Council had jurisdiction over. Councillor Hamer said the Manchester company could not do anything as yet, because their provisional order would not be obtained until next session. Until then the company could not do anything. A Member: Providing the electric company make application this session, and get power, will it throw Manchester over altogether? The Chairman: I cannot tell you. The Clerk observed that there were already about 20 in opposition to the electric scheme. Councillor Hodgson: Supposing the electric company get their order and proceed with the work, Manchester cannot come in only by arrangement with the electric company. Councillor Hamer said their position was perfectly plain. Under certain circumstances the Council were prepared to support the electric scheme, but seeing that Manchester proposed to give them something more than the electric company, they were bound to support Manchester.

Sheffield.—The electric light and power company are fitting up the Langwith Colliery with the electric light. A powerful dynamo has been put down capable of lighting up the whole of the premises, both on the surface and under ground. The Parliamentary Committee have resolved, "That Messrs. Walter Webb and Co. be asked to state whether, having regard to the expressed desire

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of the Sheffield Tramways Company to assist the Corporation in giving effect to its desire, their clients are willing to continue to work the tramways subject to 12 months' notice to be given at any time, but that under any circumstances the Corporation will prefer to pay the amount due to the company at the termination of the present lease, and that the Sheffield Company be informed that if they are prepared to negotiate with the Corporation on these lines, a conference between the committee and representatives of the company be forthwith arranged." At the same meeting a sub-committee was appointed for the purpose of preparing a scheme for the extension of the city tramways, to be submitted to Parliament in 1897, with power for the sub committee to obtain such professional advice in the preparation of the scheme as they may require. The Electric Light and Power Company have made a third call of £1 per share on the new capital they issued at the beginning of last year.

Bath.—The annual meeting of the shareholders of the Bath Electric Lighting Company has been held, Mr T. O. Callender, of London, presiding. The balance-sheet showed a gross profit for 1895 of £1,570, and the report was described as the most satisfactory ever laid before the company. At the commencement of the year a balance was brought forward of £388, giving a total sufficient to pay a 4 per cent. dividend and leave a surplus of about £150. The directors, however, considered it expedient to place the amount to a reserve account, after the payment of directors' fees. The Chairman, in moving the adoption of the report, referred to the contest between the company and the local authority. As a result of the recent conference of the company and the authority with Sir Courtenay Boyle, representing the Board of Trade, Prof. Kennedy had been appointed to act as valuer. Mr. Ruddock, a shareholder, asked on what ground the authority opposed their application for a provisional order. The Chairman remarked that this was what they could not understand. Mr. Titley, another shareholder, complained that the authority were attempting not only to preclude them from obtaining their provisional order, but were attempting to buy them out on the worst possible terms. A dividend of 3 per cent. was proposed by one of the shareholders, but the recommendation of the directors was carried by nine votes to six.

Guernsey.—Public meetings have been held in Guernsey, on March 4 at St. Peter-Port, and on March 5 at St. Sampson's, to consider the advisability of introducing a telephonic exchange system into the island. Both meetings were addressed by Mr. A. R. Bennett, who recommended that the work should be a popular one, undertaken either by the States of Guernsey or by a local co-operative company approved by the States. A representative of the National Telephone Company was present, and explained the terms on which his company would open a Guernsey exchange; these were, however, rejected as too onerous Ultimately the following resolutions were unanimously adopted: "(1) That it is expedient to introduce a telephonic exchange system into Guernsey with the smallest possible delay; (2) that a committee be appointed to consider the whole subject, and to take the necessary steps to bring about the establishment of an exchange by the States of Guernsey or by a co-operative company under the protection of the States." A committee consisting of 17 leading inhabitants, including several members of the Guernsey Legislature, was elected, partly at the St. Peter-Port, and partly at the St. Sampson's meeting. The committee held its first sitting on March 6, and decided that the States should be recommended to apply immediately for a license to telephone the island in terms of Clause 19 of the Treasury Minute of August 7, 1894. A telegram notifying the desire of Guernsey to manage its own telephone system and the intention to apply for a license was ordered to be despatched to the Postmaster-General.

Cork.—An enquiry has been held by Mr. W. W. Barrington, engineering inspector to the Board of Works, into the merits, from an engineering point of view, of the electric tramways scheme. Mr. Murphy said they proposed to make the tramways with a 3ft. gauge In the principal streets of the city they would have a 6in. sett pavement, with a bed of 6in of concrete. According to the specification of the Corporation on a recent occasion, when they intended to block pave one of the streets of the city, that was the sett proposed to be used. It was intended that the rails would weigh from 77lb to 80lb. a yard. They proposed in some of the streets on which there was less traffic to put in a lighter pavement of 4in. cubes. In the country they would have cross-sleeper rails 5in. deep and made up with ballast. They did not propose any pavement. On Parnell Bridge there would be a question to consider The bridge was 21ft. wide, and the promoters propose to run a double line over it. The city engineer recommended only one line, but his experience was that a double line was a greater convenience. The single line in the centre would be liable to block the traffic, while if there were two lines, one at each side, the tramcar would go with the traffic. The average length of the cars would be about 22ft. At the subsequent meeting of the Corporation the Mayor mentioned that the enquiry had been held and that the promoters had applied to the town clerk for a meeting of the Council at an early date at which they proposed formally to make application, and the probability was that a special meeting of the Council would be held towards the end of the month.

New Publications.—We have received a copy of the fifth edition of "Tabulated Weights of Iron and Steel." This is a good looking, though somewhat bulky pocket-book. compiled by Mr. C. H. Jordan for the use of naval architects, shipbuilders, and manufacturers, but the 578 pages of tables which make up this pocket-book contain information which will save much time and calculation on the part of all that have in any way to do with iron or steel construction. Messrs. Johnson and Phillips, of Old Charlton, send us an addition to their cable-list, giving particulars and prices of vulcanised rubber-covered and taped cables. Lastly, we have to acknowledge the receipt from the Brush Electrical Engineering Company, of 49, Queen Victoria-street, E C., of an advanced copy of a pamphlet they are issuing on the Raworth "Patent Universal High-Speed Engine." Though called a "pamphlet." this is really a substantially-bound and handsome-looking square book about the size of an ordinary blotting case. It contains an illustrated and detailed description of the Raworth engine and its accessories. This engine, it will be remembered. is essentially a tandem engine, the cylinders being arranged in pairs one above the other, and the valves placed between the cylinders. The engine figured in this pamphlet is of the compound single crank type, but it is also built with two cranks and two pairs of cylinders for triple or quadruple expansion. In the triple-expansion type the high-pressure and intermediate cylinders are over one crank, and two low-pressure cylinders over the other crank. In the quadruple-expansion engine the arrangement of the cylinder connection is similar to that of the compound.

Wimbledon—At a meeting of the Urban District Council a letter was read from the Local Government Board with reference to the electric lighting scheme, pointing out that they would not be prepared to entertain the proposal of the Council to borrow money until they had obtained from the Board of Trade a renewal of their license, and the Board would then only be willing to sanction a loan for the period over which the renewed license would extend. Mr. Crickmay said he would like to know why this difficulty had not been foreseen. The Clerk explained that during his long experience as clerk he had always found it to be the practice of the Local Government Board not to appoint an enquiry until they found everything in order. He thought he had reason for thinking previous to the enquiry that they were satisfied that the matter was in order, and that it only remained for the scheme to be heard on its merits. It was his impression that there had been an oversight on the part of the Local Government Board. The Chairman said the only thing they could do was either to wait until November for a provisional order or get their present license extended. There was a question whether the Board of Trade would grant an extension of the license for two years much before October. Mr. Crickmay asked why the Council should not apply for a fresh license before the present one expires. The Chairman said personally he saw no reason for not asking for an extended license forthwith, but the letter of the Board of Trade seemed to imply that they could not entertain their application until the expiry of their present license. Mr. Noller observed that they would have to wait about 15 months before they could get a provisional order. No action was taken.

Burton-on-Trent.—The electric light undertaking is gradually improving from a financial point of view. Alderman Low, at a meeting of the Town Council, made the following statement: The expenditure on capital account for buildings, machinery, mains, etc., during the year has been £1,626. 5s. 8d., which, with the amount previously expended—viz., £27,008. 6s. 4d , made a total capital outlay of £28,634. 12s. This sum includes the expenditure on the Ashby-road mains, amounting to £1,159. 2s. 4d. The amount of stock issued to that date was only £25,992. 17s , so that the capital account was overdrawn to the extent of £2 641. 15s,; during the present month, however, the new loan of £5 000 has been issued, leaving a balance now in hand of £2,358. 5s. for future requirements. The revenue account shows a total receipt of £1,050. 14s 3d., against £506. 18s. 5d. the previous 10 months, the working expenses being £1,342. 14s. 8d., against £843. 18s. 10d., showing a loss of £292. 0s. 5d., as against £337. 0s. 5d. The amount provided for dividends on stock and contribution to redemption fund was £1,487. 4s. 4d., the same as the previous year. Three per cent. stock, to the value of £707. 8s. 8d., has been cancelled, leaving the amount now outstanding at £25,285. 8s. 4d., but against this the sum of £741. 0s. 9d. is standing to the credit of the redemption fund account, of which £728. 15s. 5d. is invested at 3⅜ and 3¼ per cent , and the balance of £12. 5s. 4d. is in the hands of the treasurer. The total sum to be transferred from the general district rate is £1.779. 4s. 9d., against £1,802. 9s 3d. last year, the estimated amount being £1,860. The number of consumers at December 31, 1895, was 64, against 52 the previous year. He regretted that there were not more users of the electric light, and stated that until there were they could not expect to make any profit out of it.

Bradford.—The Town Council have adopted the minutes of the Electricity Committee. which included reports upon negotiations with the Guardians with a view to the lighting of the whole of the workhouse buildings by electricity; a resolution instructing the electrical engineer to proceed with the necessary alterations at the Bolton-road station for the purpose of adapting the works to the increased electrical pressure occasioned by the change from the two wire to the three wire system; and resolutions recommending the Council to authorise the committee to proceed with the letting of the contracts for the new electricity works, and to extend the area of the Corporation's electrical supply. Mr. Dixon, chairman of the committee, made his half-yearly statement with regard to the working of the department, and said it was progressing most satisfactorily, and was, he believed, exceeding in its results even the anticipations of its founder. The committee had added two new boilers, 300-h.p. engines made by Messrs. Willans and Robinson, and of the three-crank pattern, and also three 800-h.p. boilers made by Sir George Brown, and these were giving every satisfaction. The establishment of the three-wire system was rapidly approaching completion, and the greater part of

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the borough, if not all of it, would soon be put upon the 230-volt basis. This would add to the revenue of the department, mainly from the fact that there would be less leakage from the high pressure than from the low pressure · During 1895 the committee had sold 373 372 units, as against 307,977 in 1894, the increase being 65.395 units, and the demand being still an increasing one. The committee had at the present station a total indicated horse-power of 2,210, and this power was very often taxed to its utmost capacity There was a profit upon this department, after paying interest and sinking fund and allowing for depreciation, of £1,792. 19s. 1d , as against £918. 10s. 5d., there being an increase of profit of £874. 8s. 8d.

Dundee.—A proposal to introduce the metallic-return system in the matter of telephone wires in Dundee has been considered at a meeting of the Works Committee of the Town Council. The following letter was submitted from the general manager of the National Telephone Company: "The Board of this company has at present under consideration the question of making certain alterations to and improvements in its plant in Dundee, and, amongst other things of placing the system on what is known as the twin-wire or metallic-return principle, which involves the provision for each subscriber of a second or return wire. To do this effectively, and to secure the greatest efficiency of service, it is essential that the main routes of wires in the centre of the town should be placed underground. Having regard to the great development which is taking place in the use of the telephone service for long-distance communication, and to the fact that the Post Office has either opened, or has now in process of construction, trunk wires connecting all the principal towns in the United Kingdom, the Board has arrived at the conclusion that the time has come when the works which I have indicated ought to be undertaken, and it is ready to undertake them if the Corporation will afford the requisite assistance. As regards the interference with the streets, the company has no desire to obtain any rights therein adverse to the Corporation, and is indifferent as to how the work is done. I venture to suggest that a committee of the Corporation should be empowered to receive the representatives of the company, when the matter could be fully discussed and proper explanations given." The committee received the proposal with great cordiality, and appointed a committee to meet the representatives of the National Telephone Company. The rental collected for electricity during the 10 months ended February was £3,104 8s. 5d., an increase of £745. 1s compared with the corresponding 10 months of 1895. The cost of the supply of electric current to the High street lamps in February was £15 17s. 11d.

Tunbridge Wells—At the meeting of the Town Council it was reported that the estimate for the Lighting Committee was £200 more than the preceding half-year. Councillor Brindle said at the present time the electric light was more than paying the expense of production, and there was a slight profit towards the capital account. It only wanted an increase of consumers to ensure a contribution to the rates. When the new works got up to their full capacity he should not be surprised if the electric light undertaking yielded £1 200 to the relief of the rates, although they were so often told that it would be a burden to the rates. The Electric Lighting Committee reported that they had resolved to reject absolutely the gas-engine at the central station. A letter was received from Mr. Preece stating that Messrs. Johnson and Phillips were willing to supply a Willans engine for £750, and allow £140 in respect of the disused dynamo. It was resolved, subject to the chairman's and engineer's examination of the specification, that a Willans engine should be ordered, but that the committee were not prepared to sell the dynamo for £140. A letter was received from Dr. Gilbert claiming compensation for injury sustained by his son through the breaking of a pulley chain at the electric lighting station, and he was informed that the committee could not acknowledge any liability in the matter. It was resolved that the sum of £6. 10s. be paid annually to the Finance Committee in respect of the site of the central station. Seven tenders were received for the extension of the electric lighting station, and the committee had accepted the tender of Messrs. Strange and Son at £1,130, but as that firm wrote asking to withdraw their tender, owing to an error of £200 having been made therein, the committee recommended that the tender of Mr. J. Jarvis, at £1,356, be accepted. It was resolved that the electric lighting account do contribute £100 per annum to the relief of the rates in respect of officers' salaries not chargeable directly to the electric lighting account. Accounts amounting to £628. 12s. 4d. were recommended for payment.

Cardiff.—When the minutes of the Electric Lighting Committee came up at the County Council meeting, Mr. Good drew attention to the fact that Mr. Hallett had been appointed to report on complaints made by four fitters as to the condition of the machinery, and Mr. Good contended that the report was evasive. Mr. Melhuish was a practical fitter, and he had stated that the machinery was in a dangerous condition. His statement was confirmed by Siemens's men. He wanted to know how it happened that when the report was received on February 17 there were only seven typewritten folios, whereas on the following day, when the committee met, there was an eighth folio, which had been handwritten. That folio was not a part of the report at all. He moved that the expert's report, together with the report of the four engineers relative to the electric light machinery, be referred back to the committee for further consideration in the presence of the four engineers. There was, he added, an attempt made to shift those men from the station by other than honourable means. Mr. E. Thomas seconded the amendment, because he thought they ought to have the statements made by the fitters as well as the report of the experts. Alderman Carey ridiculed the statements of Siemens's men with regard to machinery supplied by Messrs. Davey, Paxman, and Co., who stood at the head of their trade. They were assured by the fitters, whose reports covered about 40 sheets of foolscap, that the boilers were dangerous, that there must be an accident, and that there must be loss of life. This being so, they asked one of the most experienced engineers in the town to make a report. They were careful not to engage an electrical engineer as expert because they thought he might favour the engineer at the works. No doubt, as a committee, they had made a mistake; they had engaged four fitters at 42s. a week, whereas they should have appointed three engine-drivers at 35s. and one practical fitter. Messrs. T. Morel, J. Jenkins, and Crossman spoke in the highest terms of Mr. Hallett as an engineering expert, and, on the fitters' statement being put on the table, the amendment was withdrawn, and the minutes were agreed to.

Liverpool.—A deputation from the National Telephone Company has waited on the Health Committee, and stated that the company had had under consideration the advisability of increasing the efficiency of the Liverpool service. This would mean the reconstruction of plant and the placing of the whole of the local service on what was known as the twin-wire or metallic-circuit principle. To duplicate all the existing wires of the company in Liverpool overhead would be a very serious matter, and apart from the probable interference with the service owing to the electric induction arising from the immediate contiguity of numerous wires, create a danger which might be avoided if the wires were placed underground. The directors, therefore, thought it respectful to the Corporation to place the whole matter before them, and invite their co-operation, with a view to the main routes of wires in the central parts of Liverpool being placed underground. If the Corporation consented the company would incur a very heavy expense in connection with the work—between £60,000 and £70,000—for which there would be no immediate return. In Manchester the system had been successfully adopted. The committee discussed the question, and eventually the town clerk was instructed to see what powers the Corporation possessed to deal with the highways and roads throughout the district, and to report thereon to a special meeting of the committee. The City Council propose to spend £5,500 on introducing the electric light into their chief public buildings. At the meeting of the Council Mr. R. D. Holt said he would like to see the electric light and other improvements introduced by degrees, and paid for as they went along. He objected to the policy of borrowing money and perpetually piling up debt. Mr. Petrie pointed out that in a very short time the Electric Supply Company would be taken over by the Corporation They must bear in mind that something like £3.000 per annum was spent for gas in the public buildings in Liverpool, and when they got the electric light into those buildings they would be able to effect some considerable saving. The Council's proposal was eventually agreed to. In the House of Lords on Monday the Liverpool Electric Supply Transfer Bill was read a third time and passed.

Morley.—Alderman Stockdale has been appointed chairman of the Electric Lighting Committee. The committee reported at the Council meeting that they had considered the following matters: (1) communication from the Morley Tradesmen's Society, expressing a desire of the tradesmen to have a supply of electricity; (2) an intimation from the Morley Co-operative Society that they had decided to light their premises by electricity, and had provided a place for an engine for that purpose, but if the Corporation would undertake the provision of electricity they would refrain from putting in the engine, and take the supply from the Corporation for about 500 lights; (3) the fact that various small plants were already being put up in the town for separate premises; (4) the probability that if the Corporation did not undertake the supply it would be undertaken by a private company; (5) the desirability of the matter being decided, so that mains and cables might be laid when Queen street is being repaved; and (6) the costly nature of the present supply to the town hall. The committee passed a resolution expressing the opinion that the time had now arrived when a public supply of electricity was required in the borough, and that such a supply could be profitably given. They were also of opinion that it was desirable that the ratepayers as a whole should derive any profit to be obtained from the supply, and that no private company should be allowed to obtain a monopoly or any vested interest in the matter. They therefore recommended the Corporation to proceed with the scheme recommended by Mr. Hammond, and that the town clerk at once take all necessary steps for obtaining power for the Council to proceed with the matter. Alderman Stockdale, in moving the adoption of the minutes, said the committee were very sorry indeed that the Town Hall Committee when they erected that place did not go in for "the whole hog," and he strongly urged the necessity of providing a supply for the reasons named in the minutes among others. He also gave particulars of Mr. Hammond's calculations as to the cost, etc Councillor Glover seconded the resolution, and it was supported by Councillor S. Rhodes, Councillor Scarth, and others, and passed unanimously, and the hope was expressed that the committee would take prompt action in the matter.

Imperial Tramways Company, Limited—The report of the directors of this Company, to be submitted at the general meeting to be held at the Company's offices in Bristol, states that the Dublin Southern District Tramways Company's lines being in course of reconstruction the tramways have been closed to traffic for practically the whole of the period. The directors are disappointed that they are not in a sufficiently finished state to admit of any portion of the lines being opened for public traffic at the

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date of this report. There is every prospect that the lines will be ready for opening within the next few weeks. The balance of net revenue allowed of the payment of a dividend at the rate of 1 per cent. for the whole year. During the half-year, debentures for £12 500 (making up the total of £30,000) and preference shares to the amount of £50,450 have been issued to the contractors whilst the Imperial Tramways Company Limited, have accepted £30 000 ordinary shares (entitled to rank for dividend from July 1 next) in respect of their advances to that extent for the capital outlays of this company. The company are promoting a Bill in Parliament in the present session with a view to obtaining powers for considerable extensions of their electric tramways in the city and in the districts of Pembroke, Rathmines, Clontarf, and Drumcondra. The formal assents of all these four townships have been given. The whole of the projected lines can be operated from the location of the company's central power station The Bill also provides for changing the name of this company to the "Dublin Electric Tramways Company" After referring to the Middlesbrough and Reading tramways, and the Corris Railway Company, the report says the gross revenue from the four undertakings amounts to £2,499 and the net profit to £2,469. adding to which the balance brought forward (£341) a total of £2,811 is available. Of this sum £507 has been absorbed in payment of interest on debentures and temporary advances, and the directors recommend the appropriation of the remainder as follows: for preference dividend at 6 per cent. per annum £349; ordinary dividend at 1½ per cent. per aunum, £799; addition to reserve fund, £500; and to carry forward to the next account, £654 During the half-year, debentures to the amount of £4,600 have been issued, and the premiums on same added to reserve funds

Monmouth.—The Town Clerk read the following letter from the Board of Trade at the meeting of the Council in reference to the Electric Lighting Order, 1894: "Sir,—In reply to your letter of the 18th inst. on the subject of the above-mentioned order, I am directed by the Board of Trade to state that they hope to be able, in a few days, to impose regulations and to approve the system proposed to be adopted for the supply of energy under the order. I am at the same time to forward to you the enclosed description of the system of supply in the form in which the Board propose to approve it. Description of System—A high-pressure alternating-current supply at constant pressure to transformers, some of which will be placed in a sewage pumping station belonging to the undertakers, and the others singly in cast-iron pillar boxes erected in suitable positions in the streets. From the transformers a general supply will be given at a pressure of 105 volts by means of distributing mains. The power given to any single transformer will not exceed 30,000 watts. The high-pressure mains will be concentric lead covered and armoured cables adequately insulated an l laid directly in the ground. The low-pressure mains will be separately insulated cables drawn into stoneware pipes under pavements, and cast-iron pipes under the roadways. In order to provide against any accidental charging of the iron pillar boxes, their bases will be connected to the armouring of the mains and to strips of copper laid under the pavement on each side for a distance of 3ft." In reply to enquiries, the Town Clerk stated the amount proposed to be borrowed in connection with the scheme was £20,000—£11,885 for the drainage, and £8,115 for the electric lighting. Colonel Walwyn asked the Mayor whether Messrs. Bramwell and Harris, contractors for the electrical portion, were responsible to the Council for the whole scheme The Mayor said he took it that Mr. Lailey would be responsible for the drainage portion. Messrs. Bramwell and Harris were perfectly satisfied with the scheme and would take a general supervision over the whole of it. The Mayor, in reply to a question, stated that although they were asking for powers to borrow £20,000, it did not follow that the scheme would cost that amount. They wished to be prepared for all contingencies. At a special meeting of the Town Council a letter was read from the Board of Trade approving of the scheme for the installation of electric light in the borough in accordance with the Monmouth Electric Light Act, 1894

Barrow-in-Furness.—At a meeting of the County Council there was a proposal from the Gas Committee that an electric lighting sub-committee should be formed. Councillor Smith, with reference to the appointment of this sub-committee, moved as an amendment, "That the minute be not approved, as it was desirable that a separate committee should be appointed for electric lighting purposes." The reason this sub-committee had been appointed was because the Gas and Water Committee thought it necessary to take some steps so that the provisional order obtained two years ago should not be allowed to lapse and prevent any private company undertaking the work. The Chairman said according to the standing orders the Council had passed a resolution that all the provisions of the local Acts with reference to electric lighting should be managed by the Gas and Water Committee, and in face of that he doubted if Councillor Smith was in order. Councillor Smith said he was just about to point out that this was so. His amendment did not recommend the appointment of another committee, but if it were carried he would put down a notice to that effect for next month. He contended that the matter was of sufficient importance to justify the appointment of a totally separate committee. When the Council decided on the electric light, it would no doubt be in a small way, but it would soon become a large question, and the committee would have large spending powers. In the early stages of any scheme a great deal of work would have to be done, and it was important that everything should be done thoroughly, and not in any half-hearted fashion. It was also necessary, in addition to having a separate committee, that the committee should be thoroughly representative of all the wards. The electric light system when started would no doubt be in a small way, and be kept to the central part of the town; but when the works began to pay—and he believed they would before they had been long started—then they would want to extend it to other parts of the town. He had no desire to throw any obstacle in the way of the electric light, but if they were really going to go in for it, they should go about it thoroughly in order to ensure satisfactory results. The work should be in the hands of those who had faith in the movement from the very beginning, and that was the only way they could make it pay, and be a benefit to the inhabitants. If the amendment were adopted, he would next month move that a committee be appointed consisting of two members from each ward. Councillor Thompson seconded, but after a short discussion the amendment was lost.

Brighton.—At the meeting of the Town Council the following minutes of the Lighting Committee came up for adoption: "The letter from Mr. A. J. Blaber, forwarding a memorial from residents of Edburton-road and neighbourhood with reference to the lighting of the district, was again submitted. The borough surveyor presented a plan of the neighbourhood. The manager reported that the cost of laying an electricity main in Edburton-road would be £166. It was resolved that an electricity main be laid in Edburton road, and that four lamps, each fitted with a 10-c p. electric incandescent lamp, be erected in that street. A letter was read from Councillor Griffiths forwarding a memorial from residents of Upper St. James's-street, Bristol-road, and St. George's road requesting a continuation of the street electric lighting through those streets The manager presented a report as to lighting Richmond-terrace and Lewes-road, and also the omnibus route from Grafton-street to Sussex-square by arc lamps. It was resolved that 15 arc lamps be erected in Upper St James's-street, St George's-road, and Chesham-road, and that 15 arc lamps be also erected in Lewes road and Richmond-terrace. The letter from Councillor Dunk, suggesting the erection of a lamp and refuge in Queen's Park-road at the top of Islingword-road, was again submitted. The borough surveyor presented a plan showing the lighting of the neighbourhood It was resolved that the committee deem it undesirable to adopt Mr. Dunk's suggestion It was resolved that the town clerk be instructed to appeal against the assessment of the electricity works. The committee submitted accounts for the year ended December 31 in accordance with the requirements of the Board of Trade. The revenue account showed a total expenditure of £9,561 0s. 8d; the chief item being coal and other fuel, etc., £2,596; oil, waste, water, and engine-room stores, £531. 14s. 5d; wages at generating station, £1 719 4s. 11d.; repairs and maintenance £435. 5s. 4d; distribution expenses, £1.473 0s. 5d; public lamps, £569. 15s 1d; rents and taxes, £327. 0s 11d.; management expenses, £1,838. 0s. 9d.; and special charges, £70 8s. 1d The revenue was £18,575 3s 8d., comprising a balance of £1 10s. 3d. from last year £16.177. 2s 4d. derived from sales of electricity, £1,429. 19s 11d. from public lamps, and £966. 1s. 2d. from meter rents and sundries. A gross profit of £8.927. 5s. 11d. was carried forward to the net revenue account, leaving a balance of £86. 17s. 1d. to provide for bad debts. The net revenue account showed that £1,404. 1s. 9d. had been applied to local rates and £3,000 paid to reserve fund, and that after payment of interest and sinking fund appropriations, a balance of £1,150 was carried to next account. The committee resolved that the sum of £2,000 be transferred from the electricity works account to the district fund account. It was resolved to erect an additional lamp fitted with incandescent light in Edburton-road." Great satisfaction was expressed by the Council at the success of the electric light undertaking, and it was stated that the returns from private customers were £16,177, and for street-lighting only £860, which fact alone showed that the scheme was a success. Since the commencement of the business £9,330 has been paid over to the sinking fund, and the applications for lighting are increasing at the rate of 50 per cent. as compared with last year. Deputations are constantly coming to the town from places where it is proposed to establish the electric light, and it is a matter for congratulation to Mr. Wright, the borough electrical engineer, that in sixteen instances the Brighton system has been adopted. One of the last deputations was from the St. James's Vestry, their special object being to inspect the system of arc lighting in the streets, which it is proposed shall be applied for the lighting of Pall mall. Piccadilly, Regent-street, and other principal thoroughfares. They expressed great satisfaction at what they saw, and took away with them copies of the designs of the electric light standards prepared by the borough engineer and surveyor and erected in the Brighton streets.

PROVISIONAL PATENTS, 1896.

MARCH 2.

4632. Improvements in dynamo-electric generators and motors. Frederick Henry Royce and Ernest Alexander Claremont, Hulme, Manchester. (Complete specification.)

4701. Improvements in electrically and automatically actuated shooting targets or butts. Johann Neuhold, 89, Chancery-lane, London.

4709. An improved method of and electrical apparatus for automatically reducing and cutting off the steam from and thus preventing the "racing" of marine engines. Samuel Mark Folk and David Solomon Ellis, 24, Southampton-buildings, Chancery-lane, London.

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MARCH 3

4748. An arc lamp for optical lanterns, stage and yacht projectors, or other purposes. Alfred John Beaumont, 6 Scarcroft-road York

4761. New or improved device for facilitating the fixing, adjustment, and removal of electric incandescent lamps. Frederic Harold Coulson, *Invention* Office, Mitre-court, Fleet street, London.

4773. Improvements in electric traction. Jean Claret and Olivier Vuilleumier, 47 Lincoln's inn fields, London

4774. Improvements in and connected with automatically operating variable resistances in electrical circuits. Cecil Burman Callow and Henry Bevis, 73, St. Stephen's-road Upton Park London.

4778. An improved method of obtaining electricity. Baz Faustino da Motta, 7 Lancaster-place, Strand, London.

4788. An improved method or process of converting the potential energy of carbon or carbonaceous materials into electrical energy. William White Jacques, 55, Chancery-lane, London. (Complete specification)

4805. Improvements in methods of and apparatus for magnetic separation. John Price Wetherill, 45 Southampton-buildings, Chancery-lane, London. (Complete specification.)

4806. Improvements in magnetic separators. John Price Wetherill, 45, Southampton buildings, Chancery-lane, London (Complete specification)

4807. Improvements in monocyclic electric generators. James Devonshire, 70, Chancery-lane, London. (Elihu Thomson United States) (Complete specification.)

4808. Improvements in safety appliances for electric brakes. James Devonshire 70, Chancery-lane, London. (William B Potter, United States.) (Complete specification.)

4817. Regulating mechanism for electric arc lamps. Erwin Lavens, 28, Southampton-buildings, Chancery-lane London. (Complete specification.)

4837. Improvements in or connected with circuit closers for electric bells. James Newton, 53, Chancery-lane, London.

4844. Improvements in electric arc lamps. Thomas Edgar Adams, 18, Buckingham-street, Strand, London. (Complete specification.)

4845. Improvements in electric arc lamps. Thomas Edgar Adams 18, Buckingham-street, Strand, London. (Complete specification.)

MARCH 4.

4864. Improvements in or in connection with electric motors, specially applicable to electric motors for tramway cars. Frank Michael Lewis, 30, Park row, Leeds.

4870. An improvements in the method of forming the electrical connection between portable electric table lamps and the current conductors. Archibald Denny and John Kempton, Leven Ship Yard, Dumbarton.

4910. Improvements in magnetic regulating and actuating mechanism. Regina Niewerth, 37 Cursitor-street, Chancery-lane London

4937. Improvements in plates, grids, or supports for the elements of secondary batteries. Edward Clark, Walter Clark, and Frank King, 47, Lincoln's inn-fields, London

4944. A new or improved electric arc lamp, carbon, and apparatus for the manufacture of the same. James Grieve Lorrain Norfolk House, Norfolk street, London. (Theodore M. Foote, United States) (Complete specification.)

4959. Improvements in electric arc lamps. Albert George Edwards and John Baker, 258, Uxbridge road, Hammersmith, London.

MARCH 5.

4964. Improvements in the brackets or supports of incandescent electric lamps. John Carter and William John Whiting, 24 Temple-row, Birmingham

4996. Improvements in jointing boxes for conduits carrying electrical conductors. Frederick Bathurst, 73 St Stephen's-road, Upton Park London

5008. An improvement in commutator brushes. William Winship Wardle, 28, Southampton-buildings, Chancery-lane, London.

5018. An improved electric bobbin or solenoid. Samuel Sidney Bromhead, 97, Newgate-street, London. (A Dorez, France.)

5023. Improvements in or relating to electric railways and tramways. Guy Carey Fricker, 46 Lincoln's inn-fields, London.

5028. Improvements in telegraphy and in apparatus therefor. Guglielmo Marconi, 24, Southampton-buildings, Chancery lane, London.

MARCH 6.

5041. Improvements in conductors for telegraphs, telephones, and electrical distribution. James Swinburne, 66, Victoria street, Westminster.

5098. Improvements in electrolytic processes and apparatus therefor. Giovanni Battista Baldo, 55, Chancery-lane, London. (Complete specification.)

5069. Improved moderating electric incandescent lamp and apparatus for that purpose. Godfrey Bamberg, 33, Barcombe-avenue, Leigham Court, Streatham-hill, London.

MARCH 7.

5168. A method of effecting electrical communication with a train and apparatus for that purpose. Alfred Charles Brown, Robert Burn, and Leonard George Tate, 28, Southampton-buildings, Chancery-lane London.

5171. Improvements in lifting and lowering gear for electric arc lamps, electroliers, and the like. Benjamin Richard Baker, 70 Chancery-lane. London (Complete specification.)

5178. Improvements in or connected with locomotives, also applicable to tramcars, electric cars, carriages, and other vehicles. Ellis Lever, 6 Lord-street Liverpool.

5191. Improvements in arranging underground electric current conductors for electric railways, and in means for making contact therewith. Arthur Petzenbürger, 31, Southampton-buildings, Chancery-lane, London. (Complete specification)

SPECIFICATIONS PUBLISHED.

1892.

9132. Heating and welding by electricity. Howard. (Second edition.)

1895.

530. Electric current reverser, etc. Tonking.

4490. Dynamo-electric machines. De Ferranti.

5058. Arc lamps. Rae.

7319. Electrical hot-plates. Fletcher and others.

9273. Electromagnets. Taylor.

10903. Electric currents. Stone and Barnes.

14485. Arc lamps Devonshire. (Harthan)

19860. Regulating electric motors Devonshire (Potter)

21381. Arc lights. Roubal.

22574. Electric insulating compositions. Grist.

22936. Electric commutators, etc. Truss.

1896.

964. Telephonic apparatus. Schwarze.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6¼
Brush Company, Ordinary	3	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2	1⅝-1⅞
—— 4½ per cent. Debenture Stock	100	110-113
Charing Cross and Strand	5	6¾-7¼
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7-7½
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	14-15 xd
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10-11
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2¼-2⅝
Edison and Swan United Ordinary	3	1⅛-1⅜
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅛-1⅜
—— 7 per cent. Cumulative Pref.	2	2⅛-2⅜
Elmore's Copper Depositing	2	⅝-¾
Elmore's Wire Company	2	⅝-¾
Fowler-Waring Cables	5	2-2⅛
W. T. Henley's Telegraph Works, Ordinary	10	15¾-16½
—— 7 per cent. Preference	10	16½-17½
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	19½-20½
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge Ordinary	5	7½-8
—— 6 per cent. Pref.	5	7½-7⅞
Liverpool Electric Supply, Ordinary	5	7½-8
Liverpool Overhead Railway	10	13⅜-13⅞
—— 5 per cent. Pref.	10	15⅜-16
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	5⅜-5⅝
Metropolitan Electric Supply	10	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	115-119
National Telephone, Ordinary	5	6½-7
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6⅝
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	8¾-9½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	6¾-7½
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	2½-10½
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	6-6½
Westminster Electric Supply, Ordinary	5	9½-10
Yorkshire House-to-House	5	9½-10

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NOTES.

Convalescence.—Lord Kelvin, who has been unwell, is now, we are glad to hear, reported convalescent.

Institution of Junior Engineers.—This society will give a conversazione at the Westminster Palace Hotel on Saturday week (March 28).

Lactates.—In a communication to the German Electro-Chemical Society the use of lactates of the metals in electro-plating has been suggested by Dr. Jordis.

Fire.—Late last Saturday night the battery-room of the Crystal Palace District Electric Light Supply Company, at Beardell-street, Norwood, caught fire, and sustained serious damage. The cause of the fire is unknown.

Personal.—Mr. F. A. Newington, of the Millbank Station, London, has been appointed resident electrical engineer at Edinburgh in succession to Mr. Monkhouse, who has resigned. Mr. Newington is 32 years of age, and a native of Kent.

North-East Coast Engineers.—An invitation has been received and accepted by the North-East Coast Institution of Engineers and Shipbuilders to visit Cardiff and the Bristol Channel ports during the summer. The probable date of the visit will be the week beginning on Monday, June 22.

Concert.—The fourth annual Bohemian concert of the City of London Electric Lighting Company's staff will take place at the Cannon-street Hotel on the 31st inst. There will be an orchestra of 40 performers conducted by Mr. E. Seckington. Mr. F. Bailey is to preside, and the honorary secretary is Mr. H. Bacon, 1, Great Winchester-street, E.C.

An Accumulator Problem.—In reference to our note on this subject last week, Mr. Desmond G. FitzGerald points out that the expression as given by him for the total weight of acid was

$$A + Aq + \frac{\frac{Aq \cdot A + Aq^2}{100\,A}}{n} - (A + Aq)$$

The South African Cables.—Telegraphic communication with our South African Colonies has again been reduced to a single line. On Monday a notice was issued by the Eastern Telegraph Company that the Aden-Zanzibar cable was interrupted, thus cutting off communication with East and South Africa by the East Coast route, and leaving all messages for South and East Africa to go by the West Coast line.

Institution of Electrical Engineers.—By permission of Mr. Frank Bailey, arrangements have been made for a party of students to visit the Amberley-road, Manchester-square, and Sardinia-street central stations of the Metropolitan Electric Supply Company on Saturday, the 28th inst. The party is to meet at Amberley-road at 3.30 p.m., and students desiring to be included in it should write to Mr. G. C. Allingham, Eldon House, Lyndhurst-road, Hampstead, N.W.

The Junior Engineers.—In the course of his paper on "Coal Handling for Steam Generation," read before the Institution of Junior Engineers, Mr. C. H. Fletcher remarked that the subject had received but little attention at the hands of English engineers, but owing mainly to the exertions of Mr. C. W. Hunt, of New York, its importance had been fully recognised in the United States, where many applications of special plants had been installed. Descriptions were given of appliances used for hoisting, carrying, and delivering the coal consumed in the generation of steam at various large power and locomotive coaling stations.

Royal Meteorological Society.—At the meeting of the Meteorological Society on Wednesday last, Mr. E. Mawley (president) in the chair, Mr. Frederic Gaster, F.R.Met.Soc., of the Meteorological Office, delivered a lecture on "Weather Forecasts and Stormy Warnings, how they are prepared and made known." The necessity of the isolated observer knowing the condition of the barometer at other places in order to make a reliable forecast was enforced, and the system by which the Meteorological Office obtained this information by the telegraphing of simultaneous observations was described.

Transfer of the Telephones.—It has been very generally stated that the Post Office authorities will take over the working of all the telephone trunk wires of the National Telephone Company on April 4. According to the *Standard*, however, this is not quite accurate, except as indicating the beginning of the process. The Post Office on that day will take over the trunk lines only in the South of England, or, roughly speaking, the district south of the Thames from Kent to Cornwall. The intention is to proceed gradually, taking over other districts in succession, but it is hoped that the whole transfer will be completed in the course of a few months.

Midland Mining Engineers.—At a meeting of the Midland Institute of Mining Engineers at Leeds, a paper was read by Mr. H. Wormald on "Adjustable Piston Rings," in which he described a system of adjustment invented by himself. In practice, he said, piston rings did not move out as desired or theoretically allowed for. Some system of adjustment was required to make them fit the body of the cylinder, and this he claimed to have obtained by his system of packing rings, which formed one solid block after setting in position. He quoted some cases in which the ordinary style of piston had been replaced by the Wormald piston with extremely good results. A discussion followed.

Royal Institution.—The lecture arrangements after Easter at the Royal Institution include three lectures by Mr. C. Vernon Boys on "Ripples in Air and on Water"; Prof. T. G. Bonney will give two lectures on "The Building and Sculpture of Western Europe" (the Tyndall lectures); Prof. Dewar, three lectures on "Recent Chemical Progress"; and Mr. W. Gowland, three lectures on "The Art of Working Metals in Japan." The Friday evening meetings will be resumed on April 17, when a discourse will be given by M. G. Lippmann on "Colour Photography." Succeeding discourses will probably be given by Prof. G. V. Poore, Colonel H. Watkin, C.B., Prof. Silvanus P. Thompson, Prof. J. A. Ewing, Prof. J. A. Fleming, and other gentlemen.

Proposed Pacific Cable.—The *Daily Chronicle* says, apparently on the best authority, that the Pacific Cable Conference, which is to meet at the Colonial Office directly after the Easter recess, is looked forward to with the keenest interest in Canada and Australia. The two Agents-General who are to represent Australasia are now awaiting their instructions from the Colonial Governments, and the Canadian delegates—Sir Mackenzie Bowell, the Canadian Premier, and Mr Sandford Fleming—will bring their instructions with them from Ottawa. It is understood that definite tenders will be before the conference, and the chief business will therefore be to decide, not the feasibility of the cable or its cost, but the allocation of the costs between the Colonies and the mother country, and whether it shall be a State cable or a company undertaking. There is undoubtedly a strong Colonial feeling in favour of an all-British cable, both to Australasia and later on to South Africa, and the Colonies seem ready to pay their share of the cost

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The Telephone Monopoly.—A meeting of subscribers to the Tunbridge Wells telephone exchange has been held to discuss their grievances against the National Telephone Company and the steps to remedy them. It appears that the Post Office have declined to establish an exchange at Tunbridge Wells, so that although there is great dissatisfaction with the service provided and the charge made by the National Telephone Company, there is practically no available remedy. Moreover, even were the Post Office to establish an exchange it is considered that their charges under the present scale would be prohibitive. A circular has therefore been issued by a committee of the subscribers with a view to raising the funds and obtaining the support necessary for taking definite and concerted action on the subject, and it is stated that the circular has met with a satisfactory response in this respect. The committee have also been in communication with the United Kingdom Telephone Defence Association with a view to mutual assistance.

Water Power.—The question of the advantages of utilising water power by means of electric transmission of energy is one that is being constantly discussed. On the face of it, this would seem the proper thing to be done always and everywhere. When, however, it comes to practice, the apparent promise frequently exceeds the performance. This is not the fault of the electrical part of the work, but usually arises from the inherent defects of a water-power supply. It is so seldom possible to get it anything like constant, particularly when it takes the at first sight fascinating form of a mountain stream with a good fall. Switzerland is a country of mountain streams and dear coal, and consequently has gone in for water-power installations. Yet, if we may trust the results given by Mr. Jenny, except for very small installations, or where the power has not to be taken more than three miles, these do not work out cheaper than would similar installations run with a steam-engine in a country where coal is obtainable at a reasonably low rate.

Trunk-Line Telephones.—The completion of the trunk-line telephone from London to Portsmouth was inaugurated last Friday by a conversation of a congratulatory character between the Lord Mayor of London and the Mayor of Portsmouth. The latter sent his congratulations, and expressed a hope that large benefits would accrue from the use of the wires. The Lord Mayor replied that he trusted that the telephonic communication between so important a town as Portsmouth and the City of London would be productive of much commercial benefit to each. Lord Harris, vice-president of the National Telephone Company, on behalf of the directors of the company, expressed the gratification felt at putting the Mayor of Portsmouth in communication with London. Their object was to establish speedier communication throughout the country with the utmost possible celerity. The Mayor of Portsmouth replied in suitable terms. Nothing could well be nicer—and yet there are people who complain of the service and charges of the National Telephone Company and of the system which gives it a virtual monopoly.

Electro-Harmonic Society.—The following is the programme of the smoking concert to be given by this society on Friday next, March 27, at the St. James's Hall Restaurant: Part I.: overture, "Mirella" (Gounod), the Orchestra; old Scotch song, "O, she's bonnie," Mr. Arthur Thompson; recitation, "The Taking of Lungtung Pass" (Kipling), Mr. Tammadge; vocal tarantelle, "La Danza" (Rossini), Mr. William Webster; violin solo, "Scotch Airs," Mr. T. E. Gatehouse; humorous selection, Mr. Harry Hudson; entr'acte, "Loin du Bal" (Gillet), the Orchestra. Part II.: piano and violin, "Tempo di minuetto" and "Allegro Vivace," from Sonata in G major, Op. 8 (Beethoven), Messrs. Izard and Gatehouse; Arabian love song, "Medjé" (Gounod), Mr. Arthur Thompson; piano solo, "Andante and Rondo Capriccioso" (Mendelssohn), Mr. Alfred E. Izard; recitation, "Der Dale off a Tog" (Sapte), Mr. Tammadge; songs, "The Irish Reel" and "The Donovans" (Alicia A. Needham), Mr. William Webster; violin solo, "Romance and Tarantelle" (B. Tours), Mr. T. E. Gatehouse; humorous selection, Mr. Harry Hudson; march, "Fest" (Raff), the Orchestra. The musical directors are Mr. T. E. Gatehouse and A. E. Izard.

Horseless Carriages.—A motorcart has been running about the streets of Maidstone, and has somewhat disturbed the Town Council. One councillor expressed his opinion that it was disgraceful that "it should be allowed to run about as it does," while another remarked that it would be difficult to "take the machine up," but it ought to be stopped running about the town, as "it was not only against the local laws, but also against an Imperial Act of Parliament." The Mayor said he did not know whether he was to blame for this or not. He gave permission for the carriage last week to be driven to the Athletic Ground on the day of the exhibition. He saw the chief constable in the matter, and several towns were written to with the idea of knowing what the general practice was, and it was agreed that so long as there were no complaints in Maidstone it should be allowed. It seemed hard that they should object to the carriage running in Maidstone when the law would soon allow them to run. Ultimately it was agreed that the Mayor should tell the owners of the motorcart that they must not run it about any more just for the present. At any rate, that is a more civil way of doing business than sending a summons, and probably quite as effective.

Spanish Cables.—Mr. Angel Guerra continues in *El Telegrafista Español* his advocacy of a Spanish Transatlantic line, and incidentally urges the advantages of several minor connecting links in the Spanish system. Above all, he points out the desirability of the Government having a contract with some of the companies possessing repairing ships, so that one of these would be at once available in case of any breakdown. In this way would be avoided what happened in the case of the interruptions of the Canaries cable, when all the energy and good will of the Department was unable to prevent the loss of a month or more in obtaining the authorisation of the credit necessary for the repair of the cable, not to mention the poor appearance made only recently in the case of the Tarifa and Tangiers cable left for months broken and abandoned to the mercy of the currents of the straits. With every possible sympathy with the desire of the Spaniards for a good and well-worked cable service, this is unfortunately rather a bad time for urging the undertaking of much new work. The Spanish Government has at present not too much either of credit or cash to spare, and on what it has the Cuban trouble will have a first claim. It is not probable, therefore, that we shall see Mr. Guerra's cable laid yet awhile.

The Love Tramway System.—The conduit system of electric traction worked out by Mr. Love has been recommended as a convenient one to adopt in cases where it is necessary to change from an overhead to an underground system, as, for instance, in the case of a line starting in the country and ending in a town, where the posts and overhead wires of a trolley system are not desirable. Shortly described, the system consists in replacing the overhead trolley by a pendant bar similar to a cable grip bar, carried below the car and working through a slot in

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the top of a conduit in the centre of the tramway track. This pendant bar carries at its lower end a double trolley with wheel rolling contacts or with sliding contacts, which press upwards against copper conductors carried on insulators in the conduit, which is similar in all essential respects to a cable tramway conduit. With this system the tramcar is the same as that which is used with the overhead trolley and overhead wires. The electrical motors are the same, the starting and controlling apparatus for the car is the same, and as a fact the same cars are used where the Love conduit system is laid as are used with the overhead trolleys and wires. A line at Washington has in its length both the overhead and underground systems, the cars on every journey working perfectly on both sections.

Discharge Through Gases.—Recently Mr. Lehmann summarised in the *Zeitschrift für Elektrochemie* a number of papers, chiefly from *Wiedemann's Annalen*, on the subject of the passage of electricity through gases. The view sometimes accepted is that the process of discharge is not, like electrolytic conductivity, dependent on the presence of ponderable atoms, but is a particular mode of motion of the ether filling the spaces between the atoms, which motion would take place much more freely and completely in pure ether free from atoms than in gases. Mr. Lehmann, however, adopts the theory of Faraday, which assumes a breaking down of the molecules as a result of high voltage. The disruptive discharge takes place only when the difference of potential in the gases has reached a certain value, and it is always confined to a sharply defined limit. It is not a part of a closed conducting circuit, but part of a so-called open circuit which is completed through a dielectric. The voltage between the electrodes is nearly independent of the current strength, and Ohm's law therefore does not apply. Again, the heat of the current is not proportional to the square but to the first power of the current, and therefore Joule's law does not apply. The conclusion is arrived at that the discharge is not continuous, and that Faraday's hypothesis is up to now the one which agrees most satisfactorily with observed phenomenon.

Rontgen Radiations.—The subject of the new radiations continues to occupy a space in the *Proceedings* of societies and the pages of the American and Continental technical Press which seems somewhat out of proportion to the results obtained. In reference to Mr. Le Bon's *lumière noire* experiment, it has been discovered that no Röntgen effect is produced with any amount of exposure unless the light is passed through ordinary glass. Uranium glass does better, so that the effect has some connection with the production of fluorescence, and there are no Röntgen rays at all in pure sunlight. In England the subject has been debated at the Physical Society, and the result of the proceedings at the Royal Society, particularly Lord Blythsword's experiments on the subject of reflection, will be awaited with interest. One result of the new photography has been to revive experiments of the type in which a coin or other metallic object is placed on a sensitised plate, and so connected up that the plate forms the break in an open circuit. On development an image is obtained of the coin. The *Western Electrician* has devoted a page and a half and a quantity of very pretty illustrations to work of this kind. The plate is, of course, so sensitive as to be easily affected even when there is no visible or measurable discharge, and there is no necessity to assume any Röntgen effect. When a spark actually passes, the result is very interesting.

The National Telephone Company.—At the third annual dinner of the staff of the National Telephone Company at the Holborn Restaurant, the chair was taken by Mr. W. E. L. Gaine (general manager), and among those present were Lord Harris (vice-president), Sir Albert Rollit, M.P., Mr. W. C. Quilter, M.P., Sir Robert Hunter, Prof. D. E. Hughes, Mr. W. H. Preece, Mr. H. C. Fischer, Mr. Albert Anns, Mr. F. Crisp, Mr. J. Hookey, Mr. H. E. Clare (town clerk of Liverpool), Mr. G. Tucker, Mr. R. E. Fox (town clerk of Blackburn), and Mr. Chetwynd. The Chairman, in proposing "Success to the National Telephone Company," said that during the past year they had increased their *clientèle* by nearly 9,000. They had opened 50 more exchanges, and were now sending telephone messages through the kingdom at the rate of 313,000,000 per annum. In future the activity of the company would be confined to the local requirements of the large towns, and it rested with the local authorities to furnish proper facilities to enable the company to carry on the service on the most efficient modern principles. On April 4 the trunk lines would become the property of the State, and he could assure the officials of the Post Office that the officials of the company would give them the most cordial and loyal support. He hoped the State would look carefully after their own branch, and not be too anxious to enter on that part of the business which appertained to the junior partner. The very essence of such a service as theirs was that it should be a monopoly in not more than two hands, and it was in the public interest, he believed, that the local service should be in the hands of the company rather than of the State.

A Tea Factory Plant.—In the course of an article on the use of electricity as a motive power in tea factories, the *Ceylon Observer* says the question of the transmission of electrical energy for use as motive power is one fraught with much interest for Ceylon, particularly in districts where water power is easily available. A short description is then given of a scheme which has been undertaken by Messrs. Bousted Bros. to drive the machinery in the factory of Mattakelle estate. It is proposed to erect an 80-h.p turbine on the Kotmalaeganga, which, in turn, drives a dynamo capable of generating a strong current. The current is to be carried to the factory by means of an overhead cable guarded at public places by a net suspended underneath. In the factory will be installed an electrical motor of the three-phase high-tension type. The site on which it is proposed to erect the turbine is on Lindula estate, and negotiations for securing it are in progress. It is probable that should an electrical station be established at this point electrical energy will also be supplied to Lindula. Of the financial success of the installation our contemporary is sanguine. The first cost no doubt is heavy, but if against that is reckoned the cost of firewood, now getting a scarce commodity in the district, the superintendence involved by the use of a steam-engine, and the cost of upkeep involved by the latter, it is found that a considerable saving will be effected. It is considered that the motor will require little or no looking after beyond what a coolie is able to give. This is the first venture of its kind in Ceylon, and, so far as transmitting electricity for motive power is concerned, is probably the largest in the East Indies.

Germany. — In the *Elektrotechnische Zeitschrift* for March 5 are given statistics of the number and character of the electric supply works in the German empire for 1895. In the briefest tabular form these cover six of our contemporary's exceedingly large pages. A total of 180 stations are enumerated, with an aggregate output of 40,471 kilowatts. Of these 139, giving 35,166 kilowatts, are direct-current plants. Alternating-current stations number 16, with an output of 4,396 kilowatts, and the three-phase system counts 12, with 4,468 kilowatts. Four works, with

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1,746 kilowatts, are mixed tri-phase and direct; while there are two classed as mixed alternating and direct, with a joint output of 115 kilowatts. Compared with the numbers of the previous year, there is a gain of 19 direct-current plants, and only one simple alternating. Of the tri-phase plants four are new, and the tri-phase and direct have not only increased from two to four, but the kilowatts have risen from 646 to 1,746. On the other hand, there seems to be one less combined alternating and direct than in the previous year. It may be added that in 102 of the direct-current plants accumulators are used. With reference to the source of power, steam heads the list with 99 plants. Counting by number only, water power makes a good show with 41, especially when 19 water-power stations which have steam-power plant only as a reserve are added. The aggregate kilowatts, however, of these are only 4,224 and 2,280 respectively, so that reckoned in this way the proportion comes out very differently. With regard to the magnitude of the stations, eight are over 1,000 kilowatts and 20 over 500 kilowatts. The annual increase in the number of stations since 1888 appears to have been about 20, but it is stated that there are now 82 either about to be commenced building or definitely decided on.

Lighting Jute Mills.—In a report on the hours of working in jute mills in Bengal which has been made by Sir John Leng, M.P., to the *Dundee Advertiser*, mention is made of the use of the electric light to enable the work to be done in shifts. Whereas in Dundee working in shifts is unknown, the method of working in the Indian mills has long been different. The habits of the natives, consequent on the great heat during nine months of the year, their weaker constitutions, the distance in some cases of their dwellings, and their love of bathing, led them to prefer working in what may be described as alternating shifts, so that they might work at two different parts of the day with a pretty long interval between. Until recently the engines started at daylight in the morning and ran till sunset—about half-past five in winter and seven in summer. Artificial lighting by either oil or gas would have been considered objectionable on account alike of the risks of fire, the fumes, and the heat. The idea occurred to Messrs. Birkmyre, the proprietors of the Hastings Mill, that by running night and day, with the electric light, they could double, or nearly double, the production from the same machinery. The idea of using the electric light by them was not carried out until it was known that it had been satisfactorily introduced in several Dundee mills. Others then resolved to try it in their mills in order to secure a more uniform day of working hours. There are still a number of the older and larger mills that have not adopted the electric light, believing that the old-fashioned system of working from sunrise to sunset is more profitable. The mills at present using the electric light are the Howrah, Gourepore, Ganges, Seebpore, Fort Gloster, Samnuggur, Titaghur, and Victoria, the majority of which during the winter months run 14 hours a day, but the last three stop at half-past two on Saturdays.

Acetylene.—Mr. J. C. McMynn, in the course of a paper read before the North-Western Electrical Association at Milwaukee on the use of acetylene, sums up the situation from the standpoint of the American electrical supply companies. Acetylene, he says, has an illuminating power much greater than common gas. No investment for street mains is necessary, hence the gas companies must use it either as an enricher or as an adjunct to their present system to supply isolated buildings and residences, which can be reached neither by their present mains nor by electric lights. If they obtain the rights for using acetylene, they will have a weapon which will be as much stronger than the Welsbach burner as the acetylene flame is stronger than the Welsbach light. To produce this gas or calcium carbide, the gas companies must put in electric plants, which, when not in use making carbide, can be placed in competition in electric lighting. There are places, and many of them, where nothing will ever supersede the use of electric lights, but when it is considered that only 5 per cent. of the residents of Southern Wisconsin are reached by gas and only 30 per cent. are reached in Milwaukee, and that even less are supplied with electric light, there is a field opened which is wonderful in the possibilities for successful investments and large business. Most lighting plants are idle during at least half the time, and could by manufacturing calcium carbide be made producing plants for the whole time, and could thus reach a territory which cannot be reached by either the gas or electric supply companies. As for cost, since one-third cubic foot of acetylene gas burned per hour gives more illumination than a 16-c.p. incandescent light or five cubic feet of ordinary gas, Mr. McMynn estimates that acetylene will work out very much more cheaply than either incandescent gas or electric lighting.

Bimetallic Wire.—The New York *Electrical Engineer* says the high conductivity of copper has made that metal an essential for heavy current transmission, while the telegraph and telephone services have long since adopted and are constantly increasing their use of it. But, unfortunately, the high conductivity of copper is accompanied by low tensile strength as compared with iron or steel, and the latter, on the other hand, are of low conductivity. In overhead work in America copper wires of large diameters are frequently employed to secure increased tensile strength, and even then the results sought are not obtained. As is well known, copper stretches under its own weight, and unless the slack is taken up at once innumerable line troubles appear. Having wires of large diameters to carry, it follows that large poles are required, and as copper will not permit of great spans, the poles must be placed close together. The tension on the poles is very great, bracing and guying an absolute necessity, all of which adds to the cost of the line. Copper will not corrode like iron: it is a splendid conductor of electricity, but is lacking in mechanical strength. To combine both electrical conductivity and mechanical strength it was some time ago proposed to construct a compound wire, consisting of a steel core with copper shell. Wires of this type have been made, and an example of their use are a pair of lines of the Postal Telegraph Company between New York and Chicago. The lines were erected over 10 years ago, and are still in use, with excellent results. These wires were made by depositing copper electrolytically on the steel core, but the cost involved was such that the product was too high-priced for general use. The subject, however, has again been taken up, and a bimetallic wire which has been made the subject of an American patent is to be placed upon the market. It is considered that the new wire may possibly come in useful in tramway work on the overhead system.

Electric Transportation.—The New York *Electrical Engineer* contains a short article—apparently intended to be the first of a series—by Mr. W. Baxter, jun., on the possibility of supplanting the steam locomotive on trunk railways by some means of electric traction. The rapidity with which the electric motor has invaded the street railway field in America naturally created a very general belief that it will not be long before it will enter the domain of the steam locomotive and repeat on a larger

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scale its extraordinary successes of the past. The general run of men who base their opinions wholly upon what they see and have no technical knowledge by which to be guided, take it for granted that if electric motors can propel small cars with so much success as to replace horses and cables, that there is no reason why they should not be able to do equally as well with larger carriages. Moreover, the majority of semi-informed engineers who believe that it is always wise to boom new engineering developments were not slow in coming to the front with the most positive assertions to the effect that the locomotive was doomed to oblivion and would only be known as a museum curiosity by the end of the century. One electrician when interviewed on the subject said: "Electricity will displace steam if economy, as well as speed and safety, is a factor of locomotion, not because it will make easily a speed of 100 miles an hour while steam strains itself to make 60, but because it will get 1 h.p. out of from 1lb. to 2lb. of cheap coal, while out of 6lb. of dear coal a locomotive engine can only get that same 1 h.p. It will displace it because it will be cheaper." Now, as a matter of fact, if electricity is to depend wholly upon the difference in coal consumption between locomotives and large triple-expansion stationary engines to obtain a foothold on trunk line railways, it may as well give up the contest at once. Not because the difference in coal consumption is not as great as has been claimed, but because the total cost of fuel forms but a small percentage of the cost of operating a railway system; therefore, even if the entire amount were saved the reduction in running expenses would not be so great as to enable electricity to revolutionise present methods. Mr. Baxter, however, believes that if the advantages of electric traction are put forward in a fair and impartial manner, a claim of superiority can be maintained.

New Rontgen Tube.—It will be remembered that it has been discussed whether glass is altogether the best material to use in the manufacture of vacuum tubes for the purposes of Röntgen ray photography, and whether it would not be advisable to follow out Prof. Lenard's original idea of using aluminium instead. Prof. Lenard's form of tube is somewhat difficult to construct, but a form of "ray lamp" described in the *Electrical World* appears to present fewer mechanical difficulties, and it is stated has been used with satisfactory results. The new tube—neither lamp nor tube seems quite the proper word, but a new one has yet to be devised—is the invention of Prof. Woodward, of Harvard University. It is conical in shape, and its characteristic difference from the ordinary Crookes tube is that the side or wall of the lamp—*i.e.*, the curved surface—is made of sheet aluminum, $\frac{1}{10}$in. in thickness; the base of the lamp is of solid glass, practically a plug fitted into the base of the aluminum cone with plaster of Paris, and made airtight. A metallic ring passes around the base of the cone, and holds the sides of the cone firmly to the glass bottom. Through a point a little to the side of the centre of the glass base passes the cathode pole into the lamp, and at the end of this is fastened a platinum disc, at such an angle as to be parallel with one position of the generatrix of the cone. The cathode discharge is thus thrown on one part of the cone and not on the vertex. As aluminium is a conductor the anode might be anywhere, but it is put, as a matter of fact, at the top. At the vertex there is also a glass tube with a stopcock. This glass tube is fastened in with plaster of Paris and bound by a metallic ring. A circular wooden disc is fastened on the inside of the metallic cone, to prevent any collapse of the sides on exhaustion. By this construction it has been found that the difficulty from the absorptive power of the rays by the glass of the Crookes tube has been eliminated in a most marked degree. Mr. Woodward has worked with this lamp with induced currents of between 25,000 to 30,000 volts, and with these very clearly defined radiographs of the hand have been taken in five seconds. So far as we can see, the only weak part of the "lamp" is at the vertex of the cone. At any rate, its successful use shows that the phosphorescence of glass is not necessary for the Röntgen effect. But that was also a consequence of the original experiment of Prof. Lenard, which ought to have led to the discovery of the new photography more than a year ago—and did not.

The New Photography.—As we anticipated on its first discovery, the application of the new photography to surgical purposes has not been long in coming to the front. It is no longer possible even to note the accounts of the work done in this direction, and this, and the results attained, must be left to the medical Press. It may, however, be mentioned that investigations by means of the Röntgen radiations are no longer confined to parts of no great thickness, like the hands and feet. Indeed, Mr. A. F. Stanley Kent, of St. Thomas's Hospital, London, has succeeded in transmitting the X rays completely through the body, so that the most deeply-seated viscera become visible, and the condition of such organs as the kidneys can be investigated. The photographs which have been so far taken show internally those portions of the body lying between the fifth rib down to the pelvis, and there are distinctly visible in these photographs the bone of the pelvis, the spinal column, and the lower ribs. The space occupied by the kidney is slightly more transparent in the negatives, thus indicating that the kidney itself is rather more opaque than the surrounding tissues. In this connection there at once arises the question whether it is possible in this way to diagnose the presence of renal calculi. As there seemed to be some doubt as to the opacity of the calculi, Mr. Stanley Kent took photographs with a view to clear up that point. It was found that although there is a considerable difference in the relative transparency of different stones, all of them are sufficiently opaque to render it possible to differentiate them clearly from the surrounding tissues. Somewhat similar experiments have been made by Dr. Hall-Edwards at Birmingham. As in work of this kind the use of the cryptoscope, at any rate, as a preliminary before taking photographs, would be probably desirable, it may be well to note that, according to a communication made by Mr. Herbert Jackson at the Chemical Society, the best fluorescing material to use for the disc is potassium platinicyanide. Mr. Jackson tried many other platinicyanides, besides a number of platosamine salts, but the potassium salt gave by far the best results. If, however, the use of the Röntgen rays in medical work is to become a regular practice, the next thing to be settled is who is to do the work—the doctor or the electrician. It is obvious that the general practitioner cannot use the Röntgen apparatus as he uses a stethescope, and though some of the hospitals have set up apparatus for experimental purposes, progress in this direction is necessarily limited by the fact that all medical men are not skilled electricians. On the other hand, the field has been taken by the electrical engineer. Mr. A. A. Campbell Swinton, who was one of the first to show the Röntgen photographs in this country, has arranged to establish a laboratory for this purpose at 66, Victoria-street, and the Electrical Standardising Institution has announced that patients, accompanied by their medical attendant, can be examined in this manner at Faraday House, Charing Cross-road. Others will doubtless follow.

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THE MECHANICAL EQUIVALENT OF HEAT.

BY A. H. ALLEN.

In the course of an article headed "City and Guilds of London Institute," which appeared in your issue of the 14th ult., the writer, discussing heat units and measurements, takes occasion to criticise the value used by Prof. Ayrton—1,400 foot-pounds—for the mechanical equivalent of the heat required to raise 1lb. of water 1deg. C.

This value has doubtless been taken from p. 201 of Prof. Ayrton's "Practical Electricity," which was published in 1886; it must, therefore, in the first instance be judged with due regard to the state of our knowledge of the subject at that date; and as the value of "J" is a matter of immediate interest to engineers, both electrical and mechanical, it will perhaps be well to review the question briefly.

Since the famous experiments of Joule in 1850, which gave the first close approximation to the value of the constant, many experimenters have investigated the problem, and all but one have obtained a higher value than that given by Joule. The principal results published prior to the year 1886 are tabulated below:

Date.	Observer.	Value of J.
1867	Joule	1,389·6
1870	Violle	1,427·7
1875	Puluj	1,397·6
1878	Joule	1,390·9
1878	Weber	1,386·2
1879	Rowland	1,400·9
	Mean	1,398·8

It is clear that in 1886 the exact value of J was not known within 1 per cent., and that the error caused by Prof. Ayrton's employing the number 1,400 was less than 0·1 per cent. above the mean of all results.

These results are not, however, all of the same weight; many of them are unreliable on account of defects in the apparatus used, or in the methods of research adopted. Therefore it is important to consider the accurate determinations which have been made since 1886, for these have greatly reduced the magnitude of the probable error, and have made it possible to arrive at a value for J which is certainly not far from the truth.

The whole question is summarised by Mr. E. H. Griffiths (himself a practical authority on this subject), in a paper on "The Thermal Unit," which was read at the last meeting of the British Association (Ipswich, 1895), and printed in the *Philosophical Magazine* for November, 1895. Mr. Griffiths there discusses at length the data bearing upon the question, and selects the following results as being the most worthy of consideration:

Date.	Observer.	Value of J.
1878	Joule (corrected)	1,395·8
1879	Rowland	1,400·9
1892	Miculesen	1,398·3
1892	Griffiths	1,404·0
1894	Schuster and Gannon	1,402·9
	Mean	1,400·4

Of these results, Rowland's carries the greatest weight; and Mr. Griffiths concludes that the value of J may be taken as $41{\cdot}89 \times 10^6$ ergs—*i.e.*, 1,400·9 foot-pounds, with a probable error of less than 1 in 800, the standard heat unit being defined as the gramme-degree at 15deg. C. We may, therefore, safely follow Prof. Ayrton's example of 1886 by using the number 1,400 for all practical purposes, since this differs from Rowland's result by less than 1 in 1,500, and is, therefore, well within the limits of the probable error in the latter.

The value of J in terms of the Fahrenheit scale is $\frac{5}{9} \times 1{,}400{\cdot}9$, or 778·2 foot-pounds—say, 778 in practice. Approximately the same conclusion was reached in a paper by Prof. Ayrton and Mr. Haycraft on a "Students' Simple Apparatus for Determining the Mechanical Equivalent of Heat," which was published in the *Phil. Mag.* for February, 1895; and the mean of a series of experiments recently made by a group of junior students at the Central Technical College with the same apparatus gave 1,405 for the value of J, which is less than 0·3 per cent. above the more correct value, though, of course, it cannot compare in accuracy with the results given above.

The chief difficulty that remains in the way of a more accurate determination of the equivalent is the uncertainty as to the specific heat of water at different temperatures. The temperature at which the gramme-degree is to be regarded as the standard heat unit has never been agreed upon; the calorie is vaguely defined to be "that quantity of heat which is required to raise the temperature of one gramme of water one degree Centigrade"; but whether the "one degree" is to be from 0deg. to 1deg., 14deg. to 15deg., or over any other definite range of temperature, has not been decided.

As the specific heat of water is not constant, but is a function of the temperature, the value of the calorie—and of the pound-degree—depends upon the temperature at which it is taken; this would matter little if the function referred to were known, but the difficulties in the way of accurately determining its value are of such magnitude that no closely concordant results have yet been obtained. For practical purposes, however, the difference due to this cause is inappreciable, and the value of J given above is well within the limits of accuracy attainable in all ordinary measurements.

In the same article which raised this question it is stated that "Heat generated = $0{\cdot}0315\ C^2 \times R \times t$ heat units." The writer omits to mention that the time, t, is here to be measured in *minutes*, not *seconds*, as it was in the preceding formulæ; and lower down in the formula which should read

$$[\text{Foot-pounds} =]\ 44{\cdot}25 \times C^2\ R\ t,$$

he omits the t altogether. It is not, however, omitted in this formula as given in "Practical Electricity."

The constant 0·24 used in the formula

$$\text{Heat units} = 0{\cdot}24\ C^2\ R\ t$$

should be altered to 0·239 to correspond with the corrected value of J within 0·12 per cent.

In conclusion, it is highly desirable that the value of J given above, which is already well established in use in all scientific work, should be adopted by practical engineers also; and, as in the case of the purely electrical units, this end would probably be most quickly attained by the intervention of the Board of Trade, or some other influential authority, such as the Institution of Civil Engineers. The question is one of great importance, and delay only adds to the difficulty of setting it at rest.

THE ROUEN ELECTRIC TRAMWAYS.

Electric cars have been running over the greater part of the Rouen tramway system for the past two months, but the actual inauguration—intended to mark the completion of the whole network for public service—is announced to take place on Sunday next, the 22nd inst., when a large number of invited guests will assemble for a public inspection of the more important lines, the power-house, etc., meeting afterwards at a dinner in the new buildings intended for the Rouen National Exhibition to be opened this spring.

It will, therefore, not be out of place to publish some particulars of the Rouen lines, more especially as they represent the largest network so far equipped for electric traction in France, and indeed in the whole of the Continent excepting Hamburg.

The total length of lines built and authorised in Rouen for the use of electric traction is approximately 40 kilometres, equal to, say, 25 miles of single track. Practically the whole of this distance is now equipped and operated with electric cars, the only exception being a short length of line from the cathedral to the Place Beauvoisine through the central (and older) part of the town, where the streets are extremely narrow (in several places the roadway not exceeding 13ft. in width): and also an extension of the Sotteville line to Quatre Mares, at present worked by horse cars on a half-hour service, the traffic being very small.

There are in all 10 distinct services or lines operated as follows.

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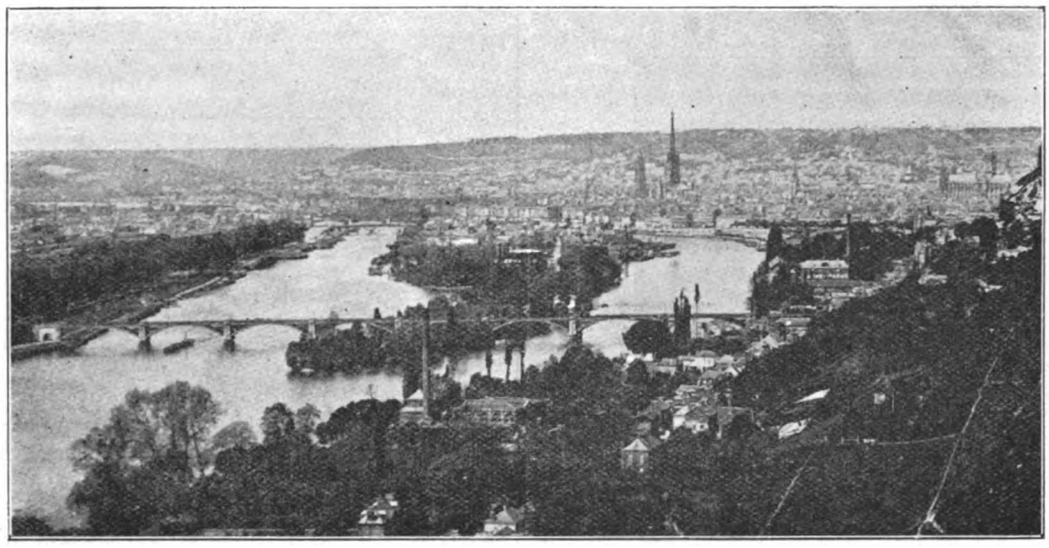
1. Pont Corneille to Maromme.
2. Quai du Mont Riboudet to Darnetal, *vid* Hotel de Ville.
3. Pont Corneille and Orleans Railway Station to Rue Verte Railway Station and Champ des Oiseaux.
4. Cathedrale to Place des Chartreux.
5. Circular line round the Boulevards and Quais.
6. Hotel de Ville to Northern Railway Station.
7. Hotel de Ville to Sotteville.
8. Extension to Quatre Mares.
9. Hotel de Ville to Petit Quevilly.
10. Place Beauvoisine to Jardin des Plantes.

between the paving setts and rails. The only cross-ties employed are of bar iron riveted to angle-pieces bolted to the rails at intervals of 9ft. or so. Chicago bonds are employed throughout at the rail joints, etc., in duplicate, and for the long bonds at junctions, etc., the same are used cut in the middle, and a splice of ordinary tinned-copper wire of equal gauge (No. 00) put in with carefully soldered joints.

Cross bonds are inserted at every fourth rail joint, and where double track is found, the two tracks are also cross-connected.

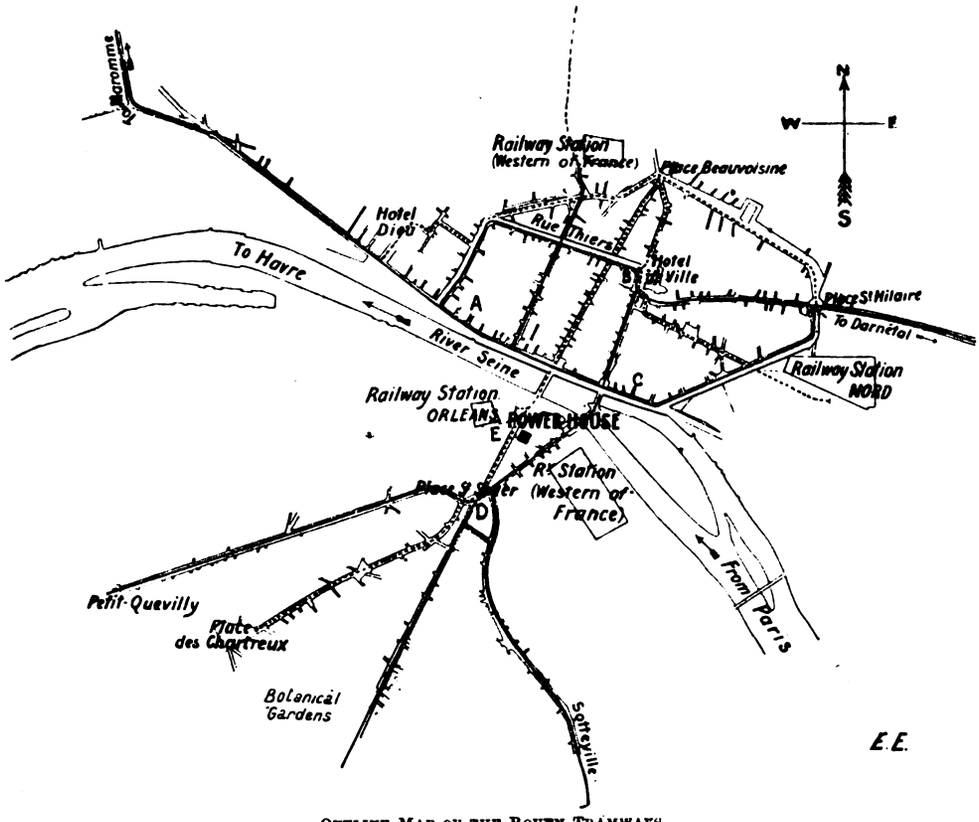
The outgoing feeders, each equal to a section of 200 square millimetres (equal to ·310 square inch), are run from



General View of Rouen, from Bonsecours.

The whole of the new lines, extensions, etc., together with the greater part of the old lines, have been laid with heavy girder rails of the Broca type, weighing 56lb and 88lb. to the yard, according to the traffic, but nearly all of the latter section. The rails are, of course, in various lengths, running

the power-house in five sections, having a total length of rather less than three miles. They terminate at points shown in the diagram by the letters A, B, C, D, E, being run underground in a trench in the roadway. They are lead covered and armoured, and therefore not otherwise protected in



OUTLINE MAP OF THE ROUEN TRAMWAYS.
Dotted lines represent the extensions and new routes opened up. Full lines show the old routes. Feeder points at A, B, C, D, and E.

up to 10 metres (33ft.), laid simply on the sandy subsoil without concrete or any attempt at foundation other than is given by continuous tamping whilst being laid. The excellent quality of the soil enables this course to be followed without any apparent subsidence or difference in level

the ground except by the usual wire netting, but iron plates are used to cover them in passing over the bridges, where the feeders are set in shallow brick and cement conduits. In each trench is also laid a return wire of tinned-copper wire (No. 0 gauge), set in a small wooden trough of

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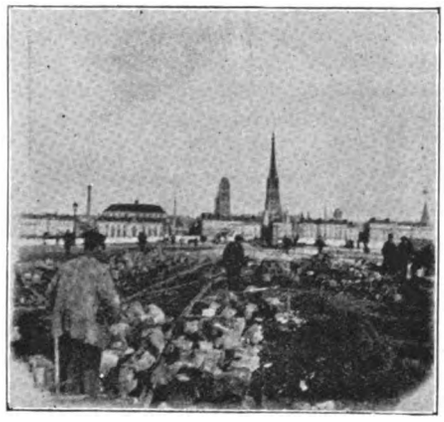
V section, which is filled up afterwards with melted pitch. From the rails nearest the power-house, heavy return feeders, each composed of a dozen or more similar bare wires, are run to the negative 'bus bars at the switchboard.

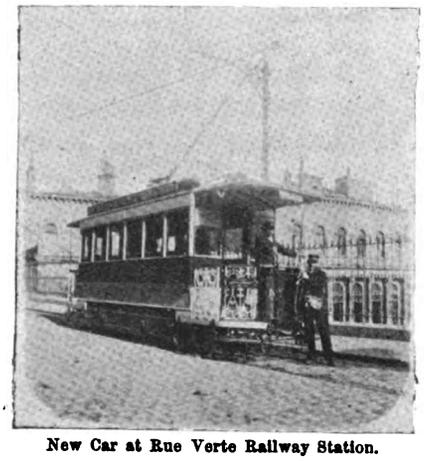
The overhead work largely consists of span wires stretched from steel poles on each side of the street in the usual manner; along the Quais, however, double-bracket poles are used, and in some of the suburbs, as well as along the Boulevards, it is found possible to employ single-bracket poles where the track runs near to the side of the road. In view of the stand that has been made so strongly in this country against the use of span wires, it is interesting to note the approximate distance of line provided with such at



Laying Track across Place St. Sever.

Rouen; there are, roughly speaking, about three times as many span wire poles erected as there are single and double bracket poles, and this proportion holds even along the most crowded and populous streets, such as the Rue Jeanne d'Arc, which is the great shopping and promenade street, Rue de la Republique, Rue Thiers, Rue Lafayette, etc.

Two trolley wires are run throughout the entire length of each line, thus serving not only to lengthen the life of the wires, but also saving heavy outlay upon feeders, as well as complication in the overhead points and crossings. Each wire has a sectional area equal to about 100,000 circular mils. The overhead parts—trolley ears, crossings, points, etc.—are all of the ordinary General Electric type, such as have



New Car at Rue Verte Railway Station.

proved acceptable from long experience in the United States and elsewhere. The poles are all set 6ft. deep in concrete, and in many places (particularly in the main streets) offered no small difficulty to the excavators, who found numerous obstacles in the way of old walls and cellars, not to speak of the naturally hard ground over most of the area covered. At points where heavy strains come on the trolley wires—*e.g.*, at curves, junctions, etc.—large poles 28ft. long and of extra heavy section are employed.

The work at the power-house has been of an extensive and elaborate nature. A suitable site from every point of view was not easily to be found, and that which was eventually decided upon lies some little distance (about 300 yards) from the River Seine, so that river water for condensation purposes is not immediately available. Coal has also to be carted into the yard, though fortunately the railway goods station is near by, as well as the river for barging fuel. At present, the coal employed is from English sources, brought up the river in sea-going boats from South Wales.

The site of the power-house is an irregular rectangle with a frontage to the Rue Lemire on the narrow side. The frontage is to be occupied by offices, porter's lodge, etc. Immediately in front, as one enters the plot of land, is an entrance way leading to the engine and dynamo house—a huge building of iron framework, with brick lining, large top and side lights, and a slated roof. The boiler-house, of solid brickwork construction, with an iron, slate, and glass roof,

New Car on the Quai de la Bourse.

stands to the left in front of the massive brick chimney, 180ft high, set between the boiler-house and engine-house. On the right of the entrance way is the refrigerator or cooling arrangement for dealing with the condenser water, enabling it to be used over and over again. Room is left for the provision of an annexe to the boiler-house, between the offices and coal-store (the latter lying just in front of the present boiler-house). There are at present installed three Babcock and Wilcox boilers, each of 250 h.p. capacity, working at a pressure of 8 atmospheres (120lb): and in the annexe, room is available for two more of the same size. The boilers are fed by a couple of Worthington pumps, the water supply, both for the boiler feed and the condensers, coming from a

Tower Wagon—Erecting Trolly Wire.

special main put down by the water company, and passing through water-meters in the basement of the offices.

The boiler gases are led through a brick flue into an economiser chamber, provided also with a by-pass into the chimney direct, and thence into the chimney. Hand-stoking is employed at present, as no great saving would be gained by mechanical appliances in a country of low wages, comparatively speaking.

The foundations for the power-house buildings are of a most solid and substantial character. Owing to the fact that the subsoil in this part of the town is largely river gravel resting upon very porous and marshy substrata, it was found necessary to cover nearly the whole area with piles, and at least 150 of these—consisting for the most part of beech

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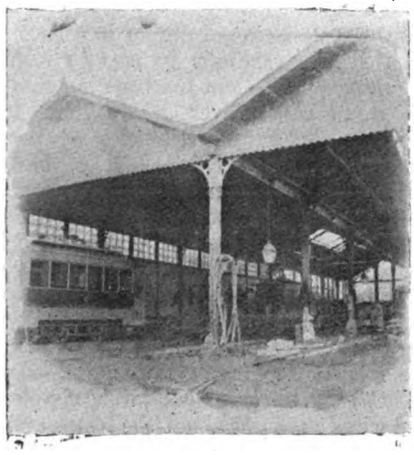
piles, 40ft. long and 12in. to 15in. diameter—were driven into the ground under the sites of boiler-house, engine-house, and chimney. On the top of the piles a heavy timber crib-work was built, and filled in with cement concrete. This again was covered with old tramway rails spaced evenly apart, another layer of concrete, then a steel grille, or network of square steel bars, and a final bed of concrete, thus forming a solid foundation 8ft. or 9ft. thick, resting on the top of the piles. There can hardly be any question of disturbance to surrounding property (rather closely inhabited) from vibration, especially with the comparatively slow-running plant employed.



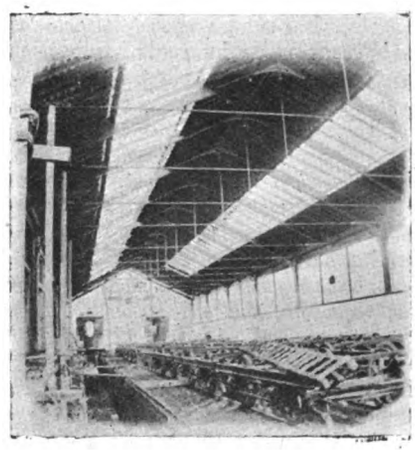
Existing Car-Sheds.

The engine and dynamo house also has an irregular rectangular shape, its length occupying the full width of the power-house plot, one end being corner-shaped. At present it contains three sets of generating plant, each equal to an output of 200 kilowatts; but the dynamos are to be replaced very shortly by 300-kilowatt machines, the engines being fully capable of working up to the larger output. They are of the horizontal condensing type with single cylinders and separate jet condensers, the pumps for latter being operated in the usual way from rocking arms on the main connecting rods. The cranks are of the overhung disc type. Heavy flywheels, about 21ft. diameter (each

New Ca on Place de la Republique.

cast in four pieces), are mounted on the crankshafts outside the main bearing, an outer bearing on separate foundation being provided in each case to help carry the weight of flywheel. The latter is turned on the surface to carry a belt driving direct on to the dynamo pulley; the speed reduction being 1 to 5, as the engines run at 85 revolutions per minute and the dynamos at 425. The engine cylinders being placed next to the dynamos owing to the small space available, it is necessary, in order to have the slack side of belt at the top, to run the engines in reverse fashion, that is, with under, instead of over, stroke for the forward movement of piston. Corliss valve gear is fitted to each engine, and a governor of Proëll type, actuated by eccentric rods and bevel gear from the crankshaft. A neat little arrangement is fitted to each governor for the purpose of checking the speed if excessive variations in load should cause a tendency to run away. When the governor moves beyond a fixed limit, it releases a small valve that destroys the condenser vacuum, and sets up a large back pressure. The engines, like those in the power-house at Havre, have been made by Messrs. Farcot, of St. Ouen.

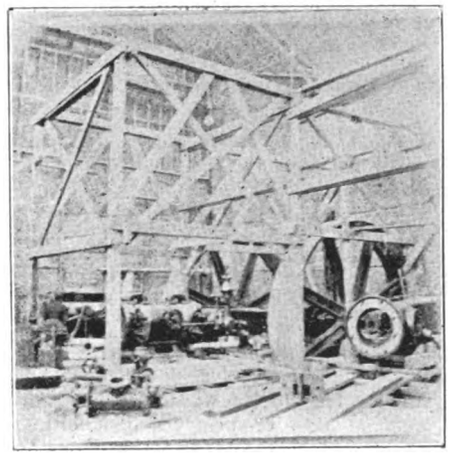
Atmospheric exhaust-pipes, with separate valves, are provided, so that the engines may be worked condensing or not, as desired. The foundation for both engines and dynamos are built up of brickwork set in cement, on the main foundation already alluded to: and in the basement thus formed



New Car-Shed, Filled with Motor Trucks.

under the engine-room floor properly so called is found space for the steam, exhaust, and condenser pipes. The main steam-valves are placed below the flooring, but, of course, each engine has its own stop-valve as well, worked from above. The piping is so arranged that no occasion need arise for cutting out more than one engine at any time for repairs, etc.

The dynamos are of the ordinary compound-wound four-pole type used by the General Electric Company, giving an output of 200 kilowatts; the pressure varies from 500 volts at no load to 550 volts at full load. Special switch pillars and connections are put in to allow of the machines being coupled in parallel. The switchboard itself is also of normal



Erecting the Engines.

type, having three double feeder panels and three generator panels, each provided with switches, resistances, magnetic blow-outs, ammeter and voltmeter connections. There being at present no restrictions in France corresponding with our Board of Trade rules, it is not compulsory to provide testing appliances such as are in use at Bristol; but the engineers of the tramway company will doubtless find that apparatus of the kind is not altogether the product of red-tapeism, but is consistent with, if not indeed conducive to, sound and economical working.

The water-cooling arrangement consists of a large iron erection through which the water is allowed to percolate against a strong current of cold air from a large rotary fan or blower, driven by an electric motor. The cooled water

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finds its way into a reservoir or tank of brickwork underneath the building, whence it is taken to the condensers.

The rolling-stock now in operation consists of 50 motor cars, 10 more being ordered to fall in with the traffic requirements. Each car is designed for 20 passengers, seated, first and second class, with standing room on the platforms for 20 more. The trucks are each fitted with two 25-h.p. motors, with single-reduction gear of the type now generally used. The controllers, one on each platform, are of the new K.2., or series-parallel type, with nine contacts, so that greater ease of regulating the speed, as well as greater differences of speed, may be obtained.

Each car is fitted with five incandescent lamps, arranged in series, three inside and one on each platform; the result is excellent, and better illumination could hardly be wanted. The cars are painted outside a light-coloured lemon-yellow on the body panels, and white elsewhere, and the appearance is very neat—most of the inhabitants of Rouen expressing decided approval of the cars, just as they have done with regard to the overhead structure, if we are to believe the local Press.

Two of the depôts already in use by the tramway company are being retained for future use, though considerable rebuilding and extending have been necessary. The stables are no longer required, but they are not quite suitable for car barns; at Maromme, therefore, the old stables have been pulled down and a fine new shed of brick, with timber and slate roof, put up, with six tracks, inspection pits being dug under them all. Accommodation is here provided for 20 or 25 cars. The chief depôt, with repair shops, etc., is situated at Trianon, near the Jardin des Plantes, or Botanical Gardens. Here the existing car sheds are being used, inspection pits being dug, however, under them at the entrance of the tracks; a new car shed alongside, with four tracks, accommodating also 20 to 25 cars, has been built. The repair shops are close alongside the latter. At both these depôts the use of a traverse table has been abolished, separate tracks being radiated into the car sheds from the main entrance track, so that in case of fire the cars may be run out of the sheds in a shorter time than would be possible with the use of a traverser.

The work of construction and equipment was begun in April last, and the entire change has therefore required close upon 10 months to effect—not at all too long a time considering the amount to be done. Indeed, the overhead work and the power-house construction has been done practically within the last seven months only. The cost has been heavy, as might be believed, the total outlay being at least £200,000.

The contracts entered into have been between the Tramways Electrical Traction Company, Limited, and the Rouen Electric Tramway Company in regard to the financial aspects of the work, also between the latter interest and the contractors for the work. These were the French Thomson-Houston Company, who took in hand the supply of all power-house plant, including the erection of chimney, etc., car trucks, motors and gear, and the overhead construction throughout, also the laying of feeders and fixing of bonds, etc.; the Brush Electrical Engineering Company, Limited, who supplied the car bodies; Monsieur U. Légé, contractor for the new buildings, power-house, etc.; and Monsieur E. Massicard, who carried out the whole of the permanent-way work at an average rate of nearly half a mile per week. Since the lines were opened, the Thomson-Houston Company (Compagnie Française) and its allied interests have shown so much confidence in the future of the system that the English interests have been bought out, and the Rouen tramways are now owned entirely by the French themselves.

In carrying out the work and in preparing for it, much credit is due to all concerned. For instance, the negotiations with local authorities, resulting in a prolongation of the tramway concession for practically 50 years, also the dealings with city and State officials, have been almost entirely in the hands of Monsieur M. Mancini, the local director of the Rouen Tramways Company. The supervision of all permanent-way work and rolling-stock was assigned to Mr. C. W. Gordon, who was sent over two years ago as manager of the company, and upon whose report, together with that of Mr. J. Clifton Robinson, C.E., the well-known tramway expert, it was practically decided by the tramway company to adopt electric traction. Mr. Gordon, since the completion of the work at Rouen, has accepted the managership of an important tramway system in Bucharest (Roumania). The engineer in charge of the work on behalf of the Compagnie Française Thomson-Houston was Mr. G. S. Albanese; and Mr. Frank B. Lea (whose name will be doubtless well known to our readers) has acted throughout as resident engineer for the Tramways Electrical Traction Company.

CENTRAL-STATION WORKING—LINE AND STATION EXPEDIENTS AND METHODS.*

BY E. B. NEWCOMB.

Soon after the installation of lights in a large paper mill it was found that the renewals in certain localities were excessive, the lamps giving out in the filaments after only a few hours' run. Upon investigation these lamps were found to be located near statically-charged paper in process of manufacture, or within the influence of highly-charged belting. In order to determine with certainty whether this was the cause of breakage, disconnected lamps were held in the hand and presented to the moving belts. After some careless handling, in which the Leyden-jar effect of a lamp was most emphatically demonstrated, it was found that a violent agitation of the filament took place, and in some cases powerful enough to fracture it. How then to make the lamps proof against this influence was the problem. The remedy employed was simple: two or three pointed wires were put about the lamps and connected to the socket, somewhat after the manner of attaching a shade-holder. By connecting the socket shell, if not otherwise grounded, to one wire of the circuit, a passage was made for the discharge and no further trouble was experienced.

A more weighty problem, however, soon presented itself. The mill in question was at first lighted by direct current, but was afterwards connected to an alternating circuit, the transformers being grouped in one locality. There were 1,300 lights. As the generating plant was made up of 1,000 light factors two alternators were required for this work. One was given a full load and the other took the balance, together with a partial load of commercial lights. The main circuits and feeders, both primary and secondary, ran parallel on the same cross-arms and structures for a larger part of their length. Everything worked satisfactorily, with one exception; lamps in certain localities at the extreme end of the distributing mains gave an unsteady light. The appearance of these was like that produced by a slack driving belt slipping at regular intervals of revolution; such, for example, as occasionally takes place in a manufactory near our station, lighted by its own plant, where the effect of a slipping belt is clearly shown by the regular up-and-down movement of the lights throughout the building.

We could not attribute our trouble to this cause, however, as it was confined to only a part of the lights. It did not occur when one alternator only was running, with part of the circuits idle, or even with the latter supplied by direct current from the old dynamos. The frequency of the fluctuations was found to depend upon the relative speed of the two alternators. It was then decided that induction must be the cause of the variation. The waves of current, if not in phase, alternately matched and mismatched, much on the principle of two piano strings, nearly, but not quite, in unison, making a noticeable wave in the tone produced. A corresponding variation was also noticed in the humming of the alternators at the station. It was clearly evident that induction did not take place in the primaries, because no commercial lights were affected. It must then be at the mill in the secondary mains having the heavier current. Believing this to be the cause, we lost no time in crossing all of the secondary feed-wires of one of the systems at about the middle of their length, as in Fig. 1, and were gratified to find a greater part of the trouble at once removed.

Later, we had a similar experience in another quarter, where the induction took place in the primaries. Circuits from two alternators ran for about a mile upon the same

* From the *Electrical World* (New York).

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four-pin cross-arms. The two inner wires carried 50 amperes of current, while the two outer wires were lightly loaded with the current required for a small number of house lights. Customers upon the latter line complained that their lights had the disagreeable appearance of trembling, as if the filaments were shaken by a jar. Not having any suitable circuit breakers at hand, we put an extra cross-arm half a mile down the line, and, cutting the outside wires,

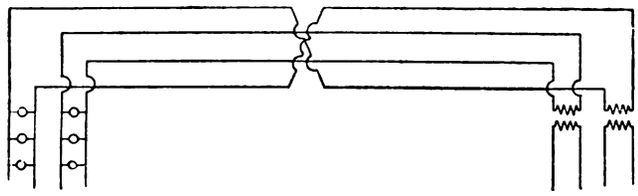


FIG. 1.

crossed them over. Our customers experienced no further trouble; in fact, they could not detect any traces of the former variation even upon closest inspection.

Our station was first equipped with direct-current apparatus distributing by the three-wire system. Later, we extended our territory and supplied lights by alternating current at points six miles from the station. So successful has been our experience in lighting with alternators that, were we to begin over again, we would discard direct-current apparatus altogether. The current from an alternator is so easily transformed to required voltages for various purposes that it leaves almost nothing to be desired.

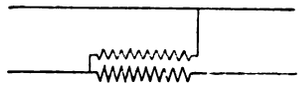
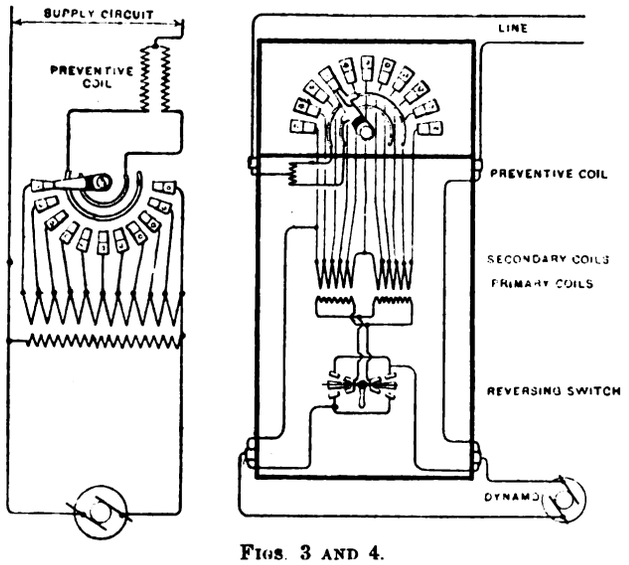


FIG. 2.

By means of additional transformers arranged with the secondary coils in series with the line, as in Fig. 2, the initial voltage can be further raised or lowered according to the relative direction of the current through the primary coils.

This general principle is exemplified in the Stillwell regulator, where provision is made for changing the length of the secondary coil, as well as reversing the primary current. With this device shown in Figs. 3 and 4, the voltage can be changed up or down 20 per cent., or a total of 40 per cent., in steps hardly noticeable. By means of



FIGS. 3 AND 4.

one of these regulators we are able to supply from the same alternator 1,100 volts for distribution at a centre one mile away, and by step-up transformers 2,200 volts for service five miles away. With the switchboard adjustment for one of the circuits and a regulator for the other, both branches are easily kept at the proper potential for the varying loads on each.

This step-up principle was put to practical use in transforming for the mill lights previously mentioned. Our standard lamps were 108 volts, while theirs were 120 volts. As a part of their lights were connected to our regular circuits, we found it desirable to retain our standard voltage and transform to that required. Two auxiliary transformers were used, one 1,000 to 100, and one 1,000 to 50, as in Fig. 5. With an initial potential of 1,100 volts, one transformer increased it 110 volts and the other 55 volts, making a total of 1,265 volts, which, transformed 10 to 1, gave as a resultant 126½ volts at the switchboard of the mill plant.

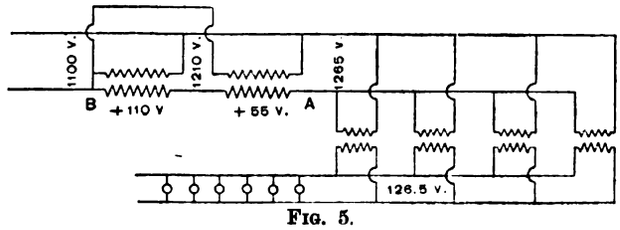


FIG. 5.

By connecting the primaries of the auxiliary transformers at A instead of B, a still higher voltage could be obtained. This would be 1,294·1 volts, made up as follows: 1,100 V. + 129·4 V. + 64·7 V. = 1,294·1 V. A still further change could be made by the use of smaller transformers for varying the primary currents of the auxiliaries, or by connecting the primaries in series. Fig. 6 shows how it would be possible to change our 2,200-volt circuit to one of 3,300 volts, and yet use only

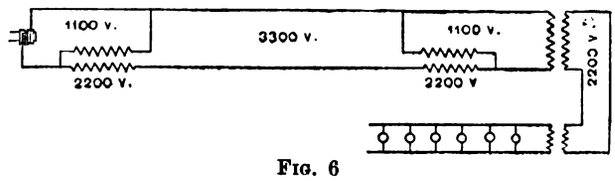


FIG. 6

our present 1,000 to 2,000-volt transformers. What would be the result of a reversal of the primary wires in this case would be a question perhaps for discussion.

It will thus be seen that a great variety of results can be attained with ordinary transformers without recourse to specially-wound apparatus for the purpose. In the cases cited, no transformers larger than 250 lights capacity were used, four of the latter having been connected in multiple, on both primary and secondary wires, to supply the maximum current mentioned. It is the practice on our lines to connect two transformers in multiple whenever one is not large enough for the service. This method allows the adoption of a standard size of transformers, say, 30 lights, for general use, so that a spare transformer or two on hand will serve for replacing any that may give out throughout the system.

In direct-current distribution the system of connecting generators in multiple has long been in use. Series work has not been so common, excepting, perhaps, as it has been found in the well-known three-wire system. That motors can be run either in multiple or in series is perhaps not so widely known. A combination of the two methods in generators as well as in motors, as shown in simple outline in Fig. 7, is rarely found. This represents an existing power plant which has been rearranged to transmit in either direction. The machines are shunt-wound, the compound

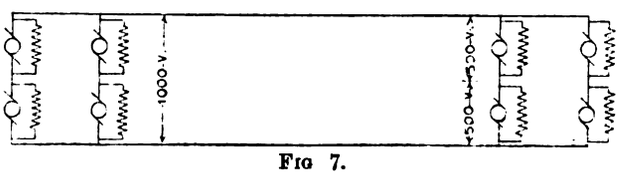


FIG 7.

winding of the original generators having been disconnected to prevent reversal when running as motors. The E.M.F. of each is 500 volts, making that of the line 1,000 volts. The motors and generators are belted respectively to one line of shafting, the pulleys having been proportioned to the relative speed of the armatures running independently as motors, without load. The machines are made to work together by means of field rheostats. No starting rheostats are needed, as either plant can be run at a speed corresponding in potential to that of the other before the

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connecting switches are closed. The load is taken up by lowering the voltage of the machines desired to work as motors, and raising it at the generator end. The transition from motors to generators is thus easily made, and so smoothly is it done that on light loads a comparison of the terminal voltages by telephone is sometimes necessary in order to determine the direction of the power.

HIGH-VOLTAGE LAMPS, AND THEIR INFLUENCE ON CENTRAL-STATION PRACTICE.*

BY G. L. ADDENBROOKE, MEMBER.

(Concluded from page 293.)

The Use of Accumulators.

This brings me to the fifth and last point mentioned at the beginning of my paper when enumerating the possibilities likely to affect central-station practice in the future—viz., the use of accumulators. In the earlier part of 1891 I did not see much likelihood of improvements in accumulators making any really fundamental alteration in central-station practice. But I must confess that in this respect events have moved faster than I anticipated, although I have been brought sufficiently into contact with them to learn what was going on in the field, and how batteries were doing as regards upkeep. Up till comparatively recently, there is no doubt accumulators have been rather a luxury and convenience in central stations than a commercial or economical necessity; but during the last two or three years considerable changes have been taking place. The maximum safe discharge rate for accumulators has been going up, while the initial cost has been going down, as well as the cost of upkeep; and extended experience holds out the hope of much longer life for the newer and improved forms of positive plates than has hitherto been the rule. Owing also to the method of supplying accumulators at a maintenance rate adopted by the leading firms, an engineer need have less hesitation in recommending clients to incur a large expenditure on them, and the risk is much less than formerly. Patents are also expiring, and considerable competition is arising in this trade, which was formerly such a close one. I have lately had to make careful enquiries about accumulators in connection with work on which I am engaged, not only as regards prices, but also as to their working, and, having got particulars about the batteries in several central stations, and held conversations with the engineers concerning them, have been considerably surprised at the progress which has been made. Taking quotations from leading makers for a battery suitable for a central station, I find that the capital cost of a battery to discharge at one kilowatt for three hours is as nearly as possible £13 for the battery alone. Several makers assure me that such a battery can be discharged at this, and even higher rates, every day regularly, without detriment or endangering the life of the positive plates. The above price does not include buildings to contain the accumulators, connections, instruments, or stands to hold them, which bring up the cost to about £19 per kilowatt on this basis for central-station batteries. The makers tell me further that they are willing to enter into contracts to maintain such batteries in a state equal to new for about 6 per cent. per annum on their capital cost, and some makers will even go lower than this. It will be found that these costs and rates of renewal are a great improvement on those ruling until comparatively recently. Now, I should not quote these figures unless I had, by private enquiries and in other ways, fairly convinced myself of their substantial accuracy. Granting that they are so, it appears to me that they raise questions of very serious import in central-station practice, particularly when coupled with the use of higher-voltage lamps. If an accumulator will give a discharge for three hours—that is, sufficient to cover the period of heavy load, or the time during which the large portion of the plant has to be kept running—a kilowatt capacity of accumulators will be equivalent to a kilowatt capacity in engines and dynamos. In continuous-current stations, when an increase of output is required—which is from time to time the position of most stations—we are therefore brought face to face with this problem. Extra plant for 200 kilowatts output, say, is required. Which is the best way of providing for it—by adding engines and boilers, or by adding accumulators and charging them during off hours from the existing plant? Now, as I have said above, an accumulator for an extra kilowatt output will cost about £19 complete and erected, including buildings; and I think engineers will generally agree with me that engines, boilers, dynamos, and steam-pipes for a kilowatt output, including buildings, and all other accessories, would cost about the same sum. If foundations, flues, chimney stalk, and everything else were considered, the comparison would be slightly in favour of accumulators. However, for our present purpose, let us assume that they are equal. We have therefore arrived at the position that the capital cost will be equal, whether we provide extra plant or extra accumulators for the increased output required, charging the accumulators from the existing plant.

As regards upkeep, if we can keep the accumulators in an efficient state for 6 per cent. on their cost, this is not greatly in excess of what would have to be allowed on plant if boilers are included, and, at any rate, the difference is not a matter of very great moment. There is no need to say anything here on the extremely low cost at which energy can be produced if a continuous load is provided night and day. Considering the advantages accumulators give in a central station providing for emergencies, reducing staff, and keeping the pressure even, it is, I think, doubtful if an engineer placed in the position indicated above—as many engineers will be placed shortly—would not be wise in recommending his corporation or his board to instal accumulators for 200 kilowatts output for three hours, instead of the extra plant, when the plant was a continous one. How far this should proceed is a moot point, dependent upon circumstances, which would need decision in each case. Possibly somewhere about one-third the maximum full-load capacity would be about right now, but with a load-factor of 10 to 15—which is about that general in central stations—if the price of accumulators came down per kilowatt output—which I think it is likely to do in the future—or their efficiency increased, it might be found desirable to instal accumulators for as much as two-thirds, or even three-fourths, of the full load, which would place electric distribution nearly on a par with gas distribution in respect to storage. To go as far as that is, however, not a question of the present—at any rate, in most cases—and therefore for our purpose this evening I propose to consider the accumulators as desirable for about one-third to one-half the full output.

It may be useful here to give a few general data relating to accumulators as they stand at present. The leading makers' prices of central-station batteries work out at about £13 per kilowatt on a discharge for three hours for the plates, cells, and acid only, whilst, including stands, erection, connections, and switching arrangements, the price works out about £17 per kilowatt, or, if buildings also are included, about £19 per kilowatt. In such a battery I find the plates and lead cells alone would weigh about 8cwt. per kilowatt output on the three-hours' discharge basis, and that 1cwt. of plates and cells costs a little under £2, or the cost comes to about £40 per ton. Now, as lead costs under £12 per ton at present, and seeing how much almost pure lead in a very simple form there is in accumulators, it does not seem unreasonable to anticipate that in the future, when accumulators are made on a much larger scale, we may see the price gradually come down to, say, £25 per ton, with, perhaps, improved capacity and life. At least, it appears to me that there is as good hope in this direction as there is of reduction in price and improvement in quality in any other department of electric engineering. If such a consummation were attained, it is pretty clear that it might pay to use accumulators for power stations, as well as lighting, wherever an eight or nine hours day was in vogue, and that they may ultimately come to exercise a much wider influence on the future of the electric industry than most engineers have anticipated. In order to gauge in some measure what has been the improvement in accumulators during the last few years, and since the question of the system of central-station supply was last prominently before this Institution, I lately took an opportunity of talking the matter over with Mr. Epstein, and I asked him if by looking up old contracts and catalogues he could give me anything definite on the subject; in reply, he has sent me the following letter: "I have looked into the question of the prices of accumulators, and I find that, comparing the prices in 1890 with the present ones, there is on an average a reduction of 25 per cent. But another and more important point is this—that whereas the types then manufactured were only allowed to be discharged in about 10 hours, necessitating in the case of shorter discharges much larger batteries than required for the purpose, the discharge rate has since then increased very considerably. Taking one with the other, I think I am justified in saying that the reduction altogether amounts to quite 50 per cent." In view of these facts, and considering that it is now the custom to buy accumulators on a moderate maintenance agreement, and also all the added experience of the last five years' work, it will be at once evident on how much sounder a basis commercially accumulators now rest, and how much stronger the arguments in favour of their employment in central stations are than they formerly were. Upon the three hours' discharge basis, I find a kilowatt capacity of accumulators occupies approximately four cubic feet space, for the cells and connections, so that we get a kilowatt-hour into 1·33 cubic feet. Now a discharge of a kilowatt-hour, allowing for losses, will keep about 15 16-c.p. lamps going for one hour. Allowing that a gas-burner using 6ft. of gas per hour is equal to a 16-c.p. lamp, the amount of space needed in a gasometer to store gas for the same amount of light

* Paper read before the Institution of Electrical Engineers, February 27.

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is $6 \times 15 = 90$ cubic feet, or 70 times as much space. Of course this is not quite a fair comparison, because nothing is allowed for stands, access, etc.; but I think it will be quite fair if we allow 10 times as much space for access, etc., as the accumulators take themselves. Even under these, the actual conditions, accumulators only occupy one-seventh the space which the equivalent gasometer would. We arrive, therefore, at the curious conclusion that, if the London gasometers were emptied of their gas and fitted up as accumulator-rooms, sufficient accumulators for lighting London could easily be arranged under working conditions in one-seventh of the space which would be available. We have, therefore, nothing very enormous to fear in the way of accumulator-houses, even if accumulators are used in the future on the most extensive scale for lighting or power purposes.

Interesting as these speculations are it is desirable, however, to return to what is more specifically our subject. It is usual at present to place the accumulators in the central station, except in a few instances, such as in Mr. King's system at Chelsea, Mr. Parker's Oxford system, and a few special places. Usually under these circumstances the accumulator is subject to the heavy drop at full load, which decreases its efficiency by 10 to 15 per cent. With 220-volt lamps the drop on the feeders within a mile radius would be much less than is usual now, and therefore the value of the accumulators would be correspondingly increased. For longer distances from the central station than a mile, however, undoubtedly the right place in most cases for accumulators will be at the feeder points. This is the more feasible with 220-volt lamps than under present practice, because the distributing network is so much larger from each feeder, and each feeder becomes the centre of a serious amount of lighting which will pay for individual attention. Although from the table I have given the cost of copper per lamp installed for feeders is very moderate, yet on a two-mile feeder it amounts to a considerable sum in the aggregate, and if by installing accumulators at the end of the feeder for one-third to half the full output the section of the feeder can be cut down by one-third or a half a very important saving is effected, and, of course, if accumulators for two-thirds or three-fourths full load were installed the cost of feeders would be correspondingly reduced. This has already been recognised in practice, and many devices have been brought out for charging accumulators in series or by the help of motor transformers using a high-tension current; but I would point out that the use of 220-volt lamps on a three-wire system does away with the necessity for any of these complications. All that is needed is a continuous-current motor transformer of the "booster" type. In this, one armature circuit is across the mains, and wound with a high resistance and many turns, while the current to the accumulators passes through the second circuit direct, the second circuit being wound with a few turns, so that the voltage of the main current in passing through the armature is raised, say, 30 per cent. The motor transformer then need only be about one-third the capacity for the charging current, and the cells can be charged at any time while the circuit is supplying lamps, so that continuity of supply without complication is ensured. By these means the cost of long feeders would be much reduced on the figures given above, which means also that it would be practicable to extend the lighting radius much further than was contemplated above at the same cost, should it be needed. An important factor is also brought in—that, having once laid a feeder of fair size, accumulators can be added at the outer end as the lighting grows, and thus a very large increase of lighting could be gradually met without relaying the feeder or disturbing the streets, which is always an expensive and troublesome operation. In what I have said above I have indicated a feeder to each half square mile as an average, or four to the square mile; but it is clear that if accumulators were employed, and it were desirable to concentrate them in order to save labour and attendance, it would be very simple to run short sub-feeders from a centre, so that one distributing point where accumulators were situated and one feeder from the central station could be economically made to serve a square mile or more. It is further worth noting that at 220 volts the cutting in or out of a cell makes less than 1 per cent. difference in the voltage, and not 2 per cent., as at present. This is an important consideration in keeping the light steady—a point the importance of which is becoming more and more recognised. The convenience of the system for arc lighting does not need pointing out, as nine arc lamps can be run in series. One more point is the effect which a general electric supply at 220 volts on the lines indicated above would have on the power-supply question. There is no difficulty in procuring already motors of any size from 50 watts upwards to run on 220-volt circuits, the number of amperes they take being, of course, half what is usual now; while for larger sizes, say above three or four kilowatts, they could, of course, be coupled across the two outers at 440 volts. If we then add the facts that the drop on the feeders would be less than at present, that the current density in the distributing system on the basis I have laid down would only be about half what it is at present—and when we consider that there would only be 1½ per cent. fall of pressure at full load on the distributing mains, and that by cross-coupling even this would be reduced—then it seems to me that it goes almost without saying that motors could be used to a far greater extent than at present is possible without appreciably affecting the regularity of the lighting. Accumulators at the feeding points would also be an important aid in this respect; if they were so used, the fall of voltage from them to the motors would rarely exceed 2 per cent., and under such circumstances motors of considerable size could be started and stopped (even without special starting resistances) without the rush of current being perceptible on neighbouring lamps. In this respect, therefore, the use of 220 volts is likely to be very advantageous, and do away with the necessity of having to lay special power mains—for some years, at any rate. The utility of having generators in the lighting stations giving the current and voltage which is needed for tramway work is also obvious; in fact, it looks as if one station in future would do all the power supply for a town, the lighting being only one adjunct of its business, and that, possibly, not the largest. With most of the lighting done by means of accumulators charged during the night, and the station supplying power to the tramways, etc., during the day, it ought to be possible to secure a very fairly even all-day load with one set of plant, instead of two, as at present. This would, of course, lead to important economies in generating expenses. In fact, it looks as if we could already see far enough ahead practically to enable Mr. Preece's prophecy to be fulfilled in a moderate time—"that the electric light would ultimately be the light of the poor man as well as of the rich."

And now I must conclude. The title of my paper was "High-Voltage Lamps, and their Influence on Central-Station Practice." In the first place, I have endeavoured to show that high-voltage lamps are thoroughly practical. Next, that high-voltage lamps are more desirable than lamps of the usual voltage and of high economy. I have also shown reasons why it is probable that the economy of high-voltage lamps may in time nearly approach that obtainable in ordinary voltage lamps. Having thus tried to establish the soundness of the position of the high-voltage lamp itself, I went on to consider what influence the adoption of a high-voltage lamp would have on central-station practice. I have shown how it simplifies and renders less costly the distribution of current, and how it improves the conditions of lighting. I think I have further made it fairly clear that for nearly all practical requirements of town lighting the direct-supply system will prove simpler and less costly, as well as more advantageous, than any system, whether direct or alternating, in which transformers are used; in fact, the necessity for this class of apparatus, except for special cases, seems to vanish. I think, therefore, that when the facts are fairly faced there does not seem much doubt that those engineers who have advised their clients to erect continuous-current direct-supply stations in the past have done wisely, and will be found to have served their clients' best interests; and that for the future alternating-current stations, even for country towns and scattered districts, should only be erected after the most careful weighing of possibilities. It is considerations of this character which have led me to keep very much in the background as regards central-station lighting for the last four years. Having been associated from the early days with alternating currents, my predilections were in that direction; and although the position seemed secure, yet, seeing the possibility of great improvements in several directions which would tell strongly in the favour of direct supply (but the exact advent of which no one could actually foretell until it arrived), it seemed to me more prudent to turn one's attention to other things for the time than to incur the risk of recommending work which might soon have to be undone. I have always expected and looked forward to a time when there would be one system of lighting, with variations merely in details, and have felt that the rivalry between the two systems would some day end as the battle of the gauges ended in the early railway days; and I think there are signs of the end now. It seems as if the narrow gauge would win again—as if the tortoise would again beat the hare, though it is true that to do so the tortoise has had to improve its pace considerably.

Newcastle-under-Lyme.—Major Marindin has held an enquiry for the Board of Trade respecting the objections made by the Corporation to the proposed provisional order of the promoters of the electric tramway scheme for connecting Hanley with Newcastle. Mr. Milward, of Birmingham, appeared for the tramway promoters; and Mr. S. Watson (from the office of the town clerk) represented the Corporation. Mr. Milward said the total length of the proposed tramway was something under three miles, of which 1,376 yards were in the area of the borough. He understood that one objection of the Corporation was in consequence of communication with Silverdale and Chesterton not being included in the present scheme, but he offered, if the opposition were withdrawn, that the promoters would pledge themselves to apply for powers to extend the line to Silverdale and Chesterton. Circulars had been sent to 4,055 ratepayers of the borough, 2,809 of whom had signed in favour of the tramway project, and only 453 against.

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RATES, ROADS, AND ELECTRICITY.

We have come to the conclusion that if horses, mules, and asses are to be abolished from street and road traction, the very best motor that can be had in exchange will and must be of electrical origin. At the present time, however, steam, gas, and oil are more practicable and more favoured. Efforts are being made to modify the law in connection with automatic motors, and it behoves everyone interested in the subject to strengthen the hands of those moving in this direction. Will it be advantageous to replace animal by inanimate traction, and to whom? Take the animals first. Mr. T. H. Brigg, in a recent paper before the Society of Engineers upon the mechanics of horse haulage, emphasised certain points of bad design leading to increased percussive action upon the feet and legs of the draught animals. Roughly, the percussive action is equal twice the weight of the animal and the weight added by bad design or necessarily added. We have little to say from the sentimental point of view—the damage to horseflesh by the present system. The point rather we wish to make is that which appeals to the pockets of ratepayers. Few electrical engineers know aught of street construction or maintenance. They could not—it is not their business—point out the differences in construction cost, in maintenance cost, in life under given conditions of the various street-paving materials now in vogue. Wood—hard or soft—macadam, granite setts, etc., are to them, and justly so, a sealed book, but to municipal engineers and ratepayers are subjects of the greatest interest. The latter have to pay the piper, and the former have to design, construct, and maintain. Now there is a consensus of professional opinion that more damage is done to the streets by the percussive action and the gripping and slipping action of the horses than by the wheels of vehicles. Assuming this opinion to be correct, the question immediately arises, Will the wear and tear of auto-motors, or whatever they are to be called, be less or greater than the wear and tear of horse traction? If the reply be that it will be less—we believe it will be much less—then a saving at once accrues to every ratepayer, and this is a consummation pre-eminently desired. The local burdens in the shape of debts—not to speak of burdens not so distributed over a series of years—have increased enormously of late years. Many of the local debts have been incurred for street construction or improvement. Money borrowed for street construction is repaid over a number of years, and it may be assumed, for example, that money borrowed for the purpose of paving a street with hard wood must be repaid by the end of the life of that hard wood. Any means whereby such life can be extended, then, will lessen the annual repayments, and so in this particular lessen the annual demand on the rates and on the ratepayers. Once bring these ideas home to the mind of the general public, there will be less hesitation in countenancing innovations. We appeal not only to owners of horses and carriages and carts, but to those who are not so blessed or cursed. There is to be a money saving all round; and an Englishman is understood to be

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most vulnerable in his pocket. It is a libellous insinuation, of course, but it fulfils a purpose. The electrical engineer ought to be looking ahead. The more rapid construction of tramways is all very well, but the amount of electrical energy required for tramway work, even if all tramways were electrically equipped, would be a mere fleabite compared with that required for vehicular traffic if all vehicles were electrically equipped. The most promising method seems to be self-contained cars, but the makers of accumulators have lost heart or come to the conclusion that we ask the impossible. We could point to other industrial operations wherein hundreds of thousands of pounds were lost, and governments in vain offered prizes, and those who ought to have known better turned back under the verdict impossible; yet the final result is absolute and unqualified success. In one particular case of the kind the successful operations are of the simplest, and, to those who knew the efforts made to reach success, of the most laughable kind. Success was achieved by an intelligent and scientific examination of the whole problem. The chemical actions were carefully analysed, and, as we say, the experiments led to success. It is not too much to say that up to the present we have had no similiar investigation into accumulator work in connection with traction work. That success is impossible we deny. But allowing it is in the dim and distant future, have electrical engineers nothing to say as to other possible methods? Are they going to let steam, gas, and oil have it all their own way? Still, if we are to wait for accumulators, is it not possible that a modified success will lead to better construction of streets and less jolting, which is said to kill the accumulators? We trust that more attention will be given to the whole subject.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE NEW PHOTOGRAPHY.

SIR,—Great improvements have been made during the past few weeks in the Röntgen photography, and the process has now been sufficiently developed to render it of practical value in surgery and medicine. Its successful application, however, requires expensive apparatus and special appliances, the working of which necessitates some technical knowledge.

Under these circumstances, acting on the advice of several eminent physicians and surgeons, I have decided to establish at this address a laboratory specially devoted to the purpose. This will be equipped with the most improved apparatus, which will be added to as experience and experiment show to be advisable. The work will be carried out under my supervision by one of my assistants, Mr. H. L. Tyson Wolff.

It is hoped that these arrangements will prove of service to medical men who may desire to have the process applied to their patients. The laboratory will, it is expected, be in working order in the course of a few days.—Yours, etc.,

A. A. C. SWINTON.

66, Victoria-street, S.W., March 11, 1896.

Bolton.—The electrical engineer has been instructed by the Corporation to furnish an estimate of the cost of laying electric mains in Bowker's-row.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

March 24, 8 p.m.—Great George-street. Ordinary meeting. "The Thermal Efficiency of Steam-Engines," by Captain H. Riall Sankey, late R.E., M.I.C.E.

March 27, 8 p.m.—Students' meeting. "Closing a Dock Entrance for Repairs," by J. S. Wise, Stud.I.C.E.

Institution of Electrical Engineers.

March 26, 8 p.m.—25, Great George-street, Westminster. Ordinary meeting. "Telephone Exchanges and their Working," by D Sinclair (member).

March 28, 8.30 p.m.—Students' class. Visit to Amberley-road, Manchester square, and Sardinia-street central stations of Metropolitan Electric Supply Company. Assemble at Amberley-road.

Institution of Junior Engineers.

March 28, 7.30 p.m.—Conversazione at Westminster Palace Hotel.

Northern Society of Electrical Engineers.

March 23, 8 p.m.—At Palatine Hotel, Manchester. Ordinary meeting. "The Regulation of Pressure and the Reduction of Light-Load Losses in Alternating-Current Systems of Electric Light," by E. W. Cowan and A. Still.

Royal Institution of Great Britain.

March 27, 9 p.m.—"New Researches on Liquid Air," by Prof. Dewar.

March 28, 3 p.m.—Last lecture on "Light," by Lord Rayleigh.

Society of Arts.

March 26, 8 30 p.m.—At the Imperial Institute, South Kensington. "Kashmir: Its People and Its Products," Mr. W. R. Lawrence, I.C.S., C.I.E.

King's College Engineering Society.

March 27, 4 p.m.—Terminal business meeting.

Electro-Harmonic Society.

March 27, 8 p.m.—Smoking concert, St. James's Hall Restaurant.

City of London Electric Lighting Company, Limited.

March 31, 7 45 p m.—The staff's fourth annual Bohemian concert, Cannon street Hotel.

Carpenters' Hall Lectures.

March 25, 8 p.m —"Blackwall Tunnel," by A. R. Binnie.

Institution of Engineers and Shipbuilders in Scotland.

March 24, 8 p.m.—At 207, Bath-street, Glasgow. Ordinary general meeting.

REVIEWS.

Submarine Telegraphy, and other Papers. By JAMES BELL, A.I.E E., and S. WILSON. London: *Electricity*, 29, Ludgate-hill.

This pamphlet contains some papers which originally appeared in the columns of our contemporary *Electricity*, with certain additions. If the contents of this little work are taken as incentives to further study, they will be valuable; if the reader assumes that when he has mastered their contents he has nothing further to learn, he will be wrong. The information given requires some preliminary knowledge as well as a continuation of study. It is, as far as it goes, fairly accurate. We think, however, that Appendix A hardly corresponds with the rest of the volume. It is a doubtful advantage to interpolate the high pressures and currents of electric lighting with the perhaps equally high pressures but infinitesimally smaller currents of submarine telegraphy. Still, we quite agree that electric light people have steadily ignored the knowledge of telegraphists. One value of this little book must not be ignored, in that it will assist the memory of those who are engaged in submarine cable work.

A First Book of Electricity and Magnetism. By W. PERREN MAYCOCK, M.I.E.E. Second edition, revised, corrected, and enlarged. Whittaker and Co.

We have been somewhat remiss in noticing this book, which was issued last year, but, if it is any excuse, quite a number of more pretentious books are in the same predicament. A large part of this book is filled with elementary facts, clearly explained and amply illustrated. In the case of Fig. 12, which shows the magnetic field of a horseshoe magnet, we are of the opinion that the illustration is slightly incorrect. There may be, and no doubt will be, differences of opinion regarding some theoretical points, but

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no one is in a position to say this theory is the only correct one. The great object of an elementary book is to try and give the known facts and phenomena and explanations of those facts and phenomena in such a manner that the young student will not have to unlearn anything. That this book is a second edition goes to prove that its contents have proved acceptable to readers.

Electrical Engineering Leaflets. By Prof. E. J. HOUSTON, Ph.D., and Prof. A E KENNELLY, F.R A S. Three Vols.: Elementary Grade, Intermediate Grade, Advanced Grade. The *Electrical Engineer* (New York).

These three volumes contain a mass of practical information, put together in an excellent manner, such as can hardly be found in any other work. Perhaps the great disadvantage these volumes possess is that they must be looked upon as a whole, and from the manner of their publication may not commend themselves to the ordinary reader. Each volume traverses somewhat the same lines, but each is a step in advance of the preceding one, each consisting of 35 leaflets, originally issued weekly, and here combined to form these volumes. However, we are more concerned about the matter than the method of presenting it, and here we find little cause for adverse criticism. Every effort seems to have been taken to give clear and simple information; historic disquisition is altogether absent. The authors have evidently in each leaflet taken a text and gone straight to the mark. The dynamo is explained as it is, not as it has been evolved; similarly with the battery, motor, transformer, and other pieces of electrical apparatus. Existing theory and existing practice is the mainspring of the work, commencing with electrical effects, E.M.F., resistance, current, Ohm's law, and even through the dynamo to incandescent lighting, arc lighting, alternating currents, alternators, and alternating-current transformers. The more important subjects occupy two or three leaflets, but usually one leaflet is devoted to each branch of the subject. If there is one objection we should raise, it is not that the authors are not up-to-date, but that they are a little too previous. They hasten to adopt magnetic units which are not universally adopted, and which we think are not altogether suitable. Our readers will remember that the suggestions at the last meeting of the British Association did not meet with fervent favour, though a contemporary played the boom for all it was worth. The authors adopt the suggestions from America for the names of the magnetic units:

$$\text{The webers} = \frac{\text{gilberts}}{\text{oersteds}}.$$

We think our names just as good—

$$\text{Lineants} = \frac{\text{pressants}}{\text{resistants}}.$$

And we neither offend the dead and gone nor the living. But as to suitability, take the gilbert, which the British Association calls the gauss. It is about four-fifths of an ampere-turn. Now, it is absolutely certain that practical men will continue the use of ampere-turns, and will not be bothered, if they can help it, to a multiplication by $\frac{4}{5}$ or $1\frac{1}{4}$ as the case may be. As for writers of books, they will probably welcome any proposed change that will make previous books out of date, and the last issued the only one up to date. So also professors who will talk learnedly about the sun growing cold in 10^x million of years, as if anyone cared a cuss about the matter except themselves and those whom they desired to impress as to their fitness for election into the Royal or other society. We have been led away over this point when 90 per cent. of the books has our highest commendation. The diagrams, the explanations, and the numerous concrete examples are excellent.

Electrical Engineering as a Profession: How to Enter It. By A. D. SOUTHAM. Third and Revised Edition. Southam and Co., 29, Paternoster-row, E.C.

The author in his preface to the third edition of this book says: "It has been thought advisable to draw out a general scheme of study for those intending to compete for one or other of the numerous scholarships and free studentships offered by the public technical institutions, and this programme is also suitable for those commencing practical work with a firm who desire to study in the evening." We would suggest that "the studious firm" in question should consult the prospectus of the Central Technical College, as the author's scheme so advisedly drawn is a badly cut extract from the same, and also is extracted without acknowledgment. It leads one to suppose that in arithmetic "demical extraction of square and cube roots," whatever that may be, and "the use of logarithms" are the only two points requiring the attention of the rising engineer. Generally, we suppose this book will give some idea to a parent of what training to give his son, but the question of the real worth of premium apprenticeship is not touched on Descriptions of the various technical colleges and schools in the kingdom is given, but we regret to see that the length of description is almost in the inverse proportion to their practical value. The list of firms who accept premium apprentices is given, with some details of the course of instruction offered, but here again there has been no discrimination. In fact, although the printing and illustrations are good, the lack of originality and the wholesale use of cuttings from descriptions written by interested parties militates against the value of the book.

THE HIEATZMAN MAGAZINE FUSE-BOX AND KNIFE-SWITCH.

Quite a novelty in electric apparatus, whereby, it is claimed, a great saving of time, labour, and money is obtained, is brought out in the Hieatzman magazine fuse-box and knife-switch, which is sufficiently shown in the illustrations herewith to be readily understood. For general

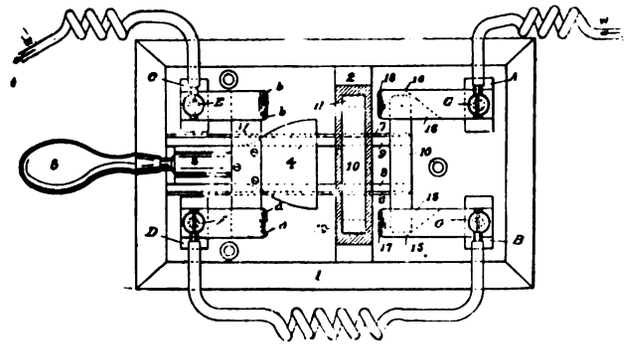

FIG. 1.

use a modification of this form will be constructed that will operate with even greater practical results—*i.e.*, a centrifugal, instead of a reciprocating, movement of the handle will be employed, as contacts can be more instantaneously made and broken with such construction. Fig. 1 is a top plan view. Fig. 2 is a view in elevation, part half-sectional.

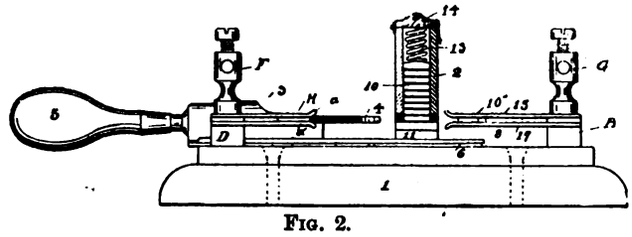

FIG. 2.

Referring to the illustrations: 1 is a base block of any suitable non-conducting material—the terminals, A G, B G', D F, and C E, are fastened one at each corner thereto; 2 is the magazine fuse-box; the plunger-block, 3, with its extending blade, 4, and operated by the handle, 5, has a reciprocating movement in the grooves, 6 and 7, which are formed by the rabbets, 8 and 9. On the top of the plunger-block, 3, is also fastened the switch-blade, H.

The magazine box, 2, has studs or small inward projec-

* From the *Electrical Review* (New York).

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tions, 11 and 12, which keep the fuses, 10, from passing straight through, and with the concert action of the spring, 13, hold the fuses, 10, always in position. *a a'*, *b b*, 15, 17 and 16, 18 are the fingers of the various terminals to which they are affixed. The fingers 17 and 18 are constructed with projections, 15' and 16', on their inner sides.

The operation of the device is extremely simple, and can be readily understood. With the switch-blade, H, and the fuse, 10', in position between their respective terminals, the circuit is closed and the flow of the current is uninterrupted. Should the fuse "blow," thereby breaking the circuit, the insertion of another fuse is accomplished in the following simple manner: Push the handle in, which at the same time moves the plunger-block forward. This movement withdraws the switch-blade from between its terminal fingers; the extending blade strikes the lowest fuse within the magazine box and moves it forward into position between the fingers of the respective terminals for its reception. The end or ends of the burnt fuse are also at the same time by this movement forced from the terminals by the angles on the inside projections of the terminal fingers, 17 and 18. Withdrawing the handle again sharply brings the switch-blade back into position—in contact with its respective terminals—thereby completing the circuit again, and accomplishing in five seconds, it is claimed, that which, with apparatus now in vogue, requires from five to ten minutes.

The magazine fuse-box is not necessarily an adjunct of the knife-switch. It is independently operative with any kind of switch.

A METHOD FOR THE DETECTION OF WEAK DYNAMO FIELDS.*

BY BUCKNER SPEED.

The cotton covering of the wire wound on dynamo fields is subject to deterioration from three principal causes—slow carbonisation due to heat, oil from the bearings, and insufficiently baked shellac. These changes in the insulation of the wire allow the current to pass from layer to layer of the wire instead of all passing through the wire itself, and the field may thereby be greatly weakened, and yet show no ground from the field wire to the field core. The only cure for such weakening is to rewind the spool with new wire.

The spool or spools requiring rewinding may usually be determined with ease if the resistance of each spool be taken when first received from the factory. If, however, the original resistances cannot be obtained, and there is no certainty that the coils all had equal resistances when wound, the faulty coil may be determined as follows:

Measure the resistance of each spool with a Weston voltmeter and Weston ammeter, using currents of various strengths; thus in the measurement of an arc machine the field wire would be connected in series with a Weston ammeter and adjustable resistances for varying the current, which could be supplied from a constant potential generator, for example. The drop across each spool would then be taken with a Weston voltmeter, when the current is held steadily at one ampere, then at two amperes, then at three, and so on up to the normal current, say 10 amperes. If the wire covering is in good condition, the resistance of the spool will of course be constant for all currents, or rise slightly, owing to the field becoming warm. But if the spool be "green" from not having been baked, or if it has become soaked with dirty oil, its resistance will be about constant for the weaker currents and will abruptly decrease upon the application of the stronger currents. The writer has measured fields in which this decrease in the resistance of the coil was as much as 20 per cent.

In case of a dry carbonised field the resistance, when hot, will be either less than when cold or it may remain about the same, or even rise slightly, but in the last case the rise in resistance with heat will be much less than the rise that is caused by the temperature coefficient (0·4 per cent. per degree C.) of the copper.

The writer has had occasion to use the above method on a number of dynamos which showed evidence of weak fields, and it has never failed to correctly indicate the weak spool. Appended is a specimen of one of these tests. The spool was unwound and the wire found to be in a very bad condition, the cotton insulation being saturated with oil and coloured green with verdigris; there were also large black spots of carbonised and oily wire covering as large as one's hand. Upon rewinding the spool the resistance became constant, as shown in the second table.

ARC DYNAMO No. —.

Top Left Coil.

Amperes.	Volts.	Ohms.
·50	3·5	7·00
1·00	7·0	7·00
1·50	10·5	7·06
2·80	19 8	7·08
4·00	28·5	7·12
6·05	43·0	7·11
8·05	55·0	6·83
8·15	55·8	6 83
9 70	66 0	6 80
9 80	67·0	6·83

After Rewinding.

2 9	20·9	7·20
5·6	40·3	7·20
8 5	61·0	7·18
9 3	67 0	7·20

For the successful use of this method several points are to be noticed. The Weston instruments are to be in the best of condition, newly calibrated and working without any sticking of their pointers. The instruments are to be removed a very considerable distance from any magnetic influences that will cause erroneous results. The measurements must be taken when the current is steady, readings taken while the current is varying being of no value. The readings on the meters must be large enough to enable an accuracy of observation of at least 1 per cent. To save the voltmeter from injury, its contact button must always be released before breaking the current in the field.

* From the *Electrical World* (New York).

PARALLELING OF ALTERNATORS.*

BY ROBERT HAMMOND, MEMBER.

(Concluded from page 299.)

Question 15.—When running in parallel, what is the synchronising current? How is this registered?

With Iron in Armature.

Altrincham.—(M. E. S.) None when the excitation of each alternator is properly adjusted.

Burton.—(L. and L.) Cannot say, as alternator ammeters swing about too much when running in parallel to be read with any accuracy.

Dublin.—(E. C. C. and L. and L.) There is practically no loss in synchronising current if engines govern properly. The amount is too small to be registered.

Halifax.—(E. C. C.) Average about two amperes. Excess of alternator ammeter over circuit ammeter.

Leeds.—(E. C. C. and L. and L.) When the ammeter needles on the dynamo ammeters are steady for a few moments, there is a very small difference between the circuit and the alternator meters—three or four amperes on the small dynamos, and about 10 amperes on the large and small together at full load. It is difficult to say what the synchronising current is.

Newport.—(L. and L.) The synchronising current at full load is very much smaller than at lighter loads, averaging 1 2 heavy, 2·5 light amperes.

Portsmouth.—(Ferranti and Parsons.) Cannot read any.

Salford.—(Hopkinson.) About five amperes at full load and at no load.

Southport.—(Mather and Platt.) About three amperes.

Without Iron in Armature.

Bristol.—(Siemens.) The synchronising current is too small to be appreciable.

Bournemouth.—(Mordey.) There is rarely any perceptible excess. The sum of the mean of the machine ammeters is always very close to the main ammeters' indication.

Cheltenham.—(Siemens.) Synchronising current is always less than one ampere.

Coatbridge.—(Mordey.) Synchronising current is at all times excessive.

Hampstead.—(Siemens.) The synchronising current is not detectable on the ammeters between the large-size alternators.

* Abstract of paper read before the Northern Society of Electrical Engineers.

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With the 20-kilowatt alternator a current of three to five amperes passes. This will be rectified by inserting a flexible coupling.

Hanley.—(Mordey.) Varies from 6 to 20 per cent. We have an instrument on each alternator, and the sum of these in parallel exceeds the instruments on circuit-boards.

Prescot.—(Two Brush, two Ferranti.) About one ampere each machine; but the synchronising current depends on the care exercised by the attendant.

Sheffield.—(Brush and Ferranti.) Ordinarily two to four amperes.

From the above it would appear that the advantage lies with II. type, if one may treat as exceptional the statement from Hanley of a 6 to 20 per cent. synchronising current.

With regard to the next question, No. 16, it is a well-known experience in electricity supply works that occasionally the load, especially in the event of a sudden darkening of the sky, comes on so rapidly that it is a matter of the greatest importance to throw on additional plant as rapidly as possible. In my "alternating works" specifications I always stipulate that "the time taken to speed up a set of plant lying idle, but with the cylinders warm, and to put into parallel with a plant running fully laden, not to exceed two minutes." In my list of supplemental questions it will be remembered there was one to elicit the time actually taken in practice, but unfortunately up to the time of writing very few replies have come to hand, but they show that ordinarily my limit is not far exceeded.

It occasionally, however, happens that this excellent promptitude does not occur when it is most needed, with the result that the "moment" is lost, and the work of hitting-off synchronous speed has to be repeated. If pressed for time, the switchboard attendant may desire to expedite matters by plugging in with the alternators not exactly in phase. In practice this may, I think, be more safely indulged in on a rising than a falling E.M.F., but it is important to note whether different types of machine show any difference of behaviour on being so roughly treated. Here are the replies which I have received on this head:

Question 16.—Can you connect into parallel if the alternators are a little out of phase?

It would appear that both types stand this rough usage equally well: indeed, according to the Deptford experience, they prefer to begin their united life with a slight quarrel. It is here that the lag set up by self-induction plays an important part. By self-induction is simply meant the well-known action owing to which the current produced in a circuit lags behind the E.M.F. given by the armature of the machine. The Bristol answer is as follows: By paralleling through impedance, successful parallels have been made when the machines have been crossing phase about 120 times a minute, and on one or two occasions have been paralleled when running in reverse phase, and have pulled round without further mishap.

Doubtless the majority of those present this evening have studied the paper which Dr. John Hopkinson read on "Electric Lighting" before the Institution of Civil Engineers in 1883. He there showed that theoretically the conditions which caused two alternators to give out no current when connected in series were identically those which enabled them to run perfectly in parallel. Unless, therefore, there is any outside disturbing cause, the tendency of two machines put in parallel out of phase is to get into perfect phase and pace.

With regard to outside disturbing causes, it is evident the more give there is in the driving power the more readily they will fall into step. Belt or rope driving, therefore, has always seemed to me more likely to ensure perfect paralleling than direct driving. The facts, however, here set forth, obtained from works driving under the most varied conditions, appear incompatible with that theory, and only last month I was glad to find that at Ayr the newly-erected Siemens flywheel alternators, running at only 96 revolutions per minute, ran perfectly into parallel.

Question 17.—Have you ever known an alternator get out of step, due to any cause, while running in parallel? If so, what was the result?

With Iron in Armature.

Altrincham, Ayr, Dublin, Eastbourne, Halifax, Leeds, Newport, Portsmouth, Southport, Tunbridge Wells, Woolwich, and Woking all answer "No."

Blackpool.—(E. C. C. and L. and L.) Yes. When 100-kilowatt (L. and L.), 50-kilowatt (E. C. C.), and 100-kilowatt (E. C. C.) were running parallel. Jackcording over to change circuits, a jackcord was reversed and short-circuited the three dynamos. Voltage of all dropped; on withdrawing plug the alternators tried to take load again, but were out of step; 100-kilowatt (L. and L.) was switched out and the other two rose up again, pulling themselves into parallel.

Without Iron in Armature.

Bolton, Bristol, Bournemouth, Cardiff, Cheltenham, Chelmsford, Deptford, Exeter, Hampstead, Huddersfield, Kingston-on-Thames, Prescot, Sheffield, Sunderland, and Worcester say it has never occurred.

Coatbridge.—(Mordey.) Yes. Result was serious damage to two alternators concerned.

Hanley.—They will get sufficiently out of step to growl alternately against one another, due to bad governing of engines, causing wave of sound as per switch.

Larne.—(Mordey.) Yes, when running at very low speed; result, heavy alternation of current between alternators.

Yarmouth.—(Crompton-Brunton.) Not with a three-crank engine; have seen it occur at other stations with two-crank engines.

Mr. Hesketh's (Blackpool) quota is most interesting, as it shows, *inter alia*, how readily two machines of identical wave curves get into parallel under the most trying circumstances. The replies show that in not a single case in the kingdom have steam-driven alternators dropped out of step in their regular work, as, of course, one must consider the short-circuit described by Mr. Hesketh as a matter of rare occurrence and quite outside the range of regular working. With regard to Coatbridge, the data were supplied when the works were driven by gas-engines, and the testimony is valuable as demonstrating the unsuitability of gas-engines for driving alternators which have to run in parallel.

Question 18.—Will the alternators run equally well in parallel at any load?

The only thing I find to remark upon is the statement that the alternators at Huddersfield run best at three-quarter load. In my opinion alternators that are supplied to run in parallel should run best at their full load, being, however, capable of carrying an excess of 10 per cent. without undue heating in order to give a margin in case of the outside load rising with undue rapidity.

Question 19.—Do you employ a separate exciter to such alternator?

Question 20.—If so, do you run the exciters in parallel as well as the alternators?

Setting aside a somewhat ambiguous "sometimes" of Chelmsford, it appears that out of 34 works only 12 works use "omnibus" excitation. I appreciate to the full the advantage arising from excitation which does not vary in potential by a variation in speed of the alternator; but to secure perfect safety in parallel running, I think that separate excitation, in spite of Mr. Rider's emphatic "Certainly not," is to be preferred.

Question 21 I propose to deal with last. The answers to Questions 23 and 26 speak for themselves.

Question 23.—Do you always parallel with stop-valve wide open and then leave the plants on the governors?

[We have left these answers out, as the next question elicits practically the same information.—ED. *E. E.*]

Question 26.—Please roughly describe your method of paralleling.

Altrincham.—(M. E. S.) Control speed of plant being put into parallel by stop-valve of engine. When in synchronism and volts adjusted for load, close auxiliary paralleling switch through small fuses or self-induction coil, then close main switch, open stop valve, and adjust excitation for load as required.

Ayr.—(Siemens.) The second engine is run up to equal speed on its governor, and the plug inserted when lamp shows the phase to be correct.

Burton.—(L. and L.) By running up the engine steadily on the stop-valve we can put the machines in parallel without the slightest blink in the lights.

Dublin.—(E. C. C. and L. and L.) Engine run up to speed. Voltage set 3 per cent. higher on incoming alternator speed adjusted to synchronise and plug inserted. In an emergency the phase is caught as the engine is coming up to speed.

Halifax.—(E. C. C.) Run up to speed with stop-valve nearly closed; adjust volts of incoming machine rather higher than 'bus bars; synchronise and put on full steam, and slightly raise volts of new machine; then make final adjustment of load by hand expansion gear.

Leeds.—(E. C. C. and L. and L.) On three engines we parallel on stop-valve, and on other three we have stop-valve wide open when paralleling and adjust governor, but immediately after synchronise the stop-valves are all thrown full open and the engines run on governors.

Portsmouth.—(Ferranti and Parsons.) Fresh engine and alternator are run up to speed, then alternator is excited, volts being kept slightly in excess of the 'bus bar. Speed is controlled by the throttle, relative speed being determined by the optical effect on the field magnet produced by an alternating arc. Selection for switching-in is usually made with the speed of the fresh engine rising. A couple of lamps and a voltmeter are employed in the usual way for phasing. After switching on, the load is divided by adjusting the governors. It is in contemplation to phase the connecting-rods, as well as the alternations, by means of a belt.

Bristol.—(Siemens.) The incoming machine is first connected to the synchronising 'bus bars by means of plugs, and from

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TABLE A.—Particulars of Alternators. With Iron in Armature.

Town.	Ma	Size of alternator (kilowatts).	Weight in cwts.	Diameter.	Revolutions per minute.	Periphery at speed at rim per minute in feet.	Fly-wheel energy in foot-tons	Whether two or three crank engines.	No. of poles.	How driven.	Periodicity per second.
Altrincham		60	10	3ft. 4in.	600	6,270	—	2 (opposite).	16	Ropes.	80
Ayr	emens.	25	80	—	360	4,680	—	2	20	Direct.	60
Blackpool.....	, and L. and L.	100	280	—	95	4,216	—	2	—	Ropes.	83
Dublin	and L. and L.	150	160	5ft.	350	—	—	2	28	,,	83
		50	90	3ft. 6in.	500	—	—	2	22	Direct.	83
		200	220	7ft.	300	—	—	3	36	Ropes.	83
Halifax	E. C. C.	50	140	10ft.	120	3,768	15,072	2	20	,,	86
		100	220	11ft.	110	3,799	26,593	2	28	,,	86
		300	320	13ft.	138	5,633	61,963	2	76	,,	86
Leeds.....	E. C. C. and L. and L.	100	70(?)	5ft.	375	5,887	—	2	28	,,	83
		200	135	7ft. 6in.	328	7,708	—	2	32	,,	83
Newport	L and L.	75	—	—	525	4,156	—	2	—	,,	87·5
Salford	Hopkinson.	120	120	4ft. 5in.	450	5,400	—	2	20	,,	75
Woolwich	E. C. C. and Swinburne.	40	—	20in.	1,500	7,500	—	single	4	Belts.	50
		120	—	60in.	430	7,740	—	single	14	,,	50
Without Iron in Armature.											
Bath	Mordey.	75	120	6ft.	600	—	—	—	24	Ropes.	100
Cardiff	Siemens.	180	—	12ft.	133	—	—	3	—	Direct.	40
		40	—	6ft.	200	—	—	2	—	,,	—
Exeter	Siemens.	75	80	3ft. 11in	500	3 600	—	2	—	Ropes.	100
		50	60	3ft. 5in	600	3,600	—	2	—	,,	100
Kingston-on-Thames	Siemens.	15	—	2ft. 6in.	770	—	—	1	24	Direct.	77
		25	—	4ft.	577	—	—	2	32	,,	77
		50	—	4ft. 8in.	462	—	—	2	40	,,	77
		100	—	6ft.	385	—	—	2	48	,,	—
Worcester	Mordey.	125	150	—	430	6 827·5	—	2	28	Ropes.	100

these bars through two choking coils in series to the two lower contacts of the synchronising switch and to one primary winding of the synchronising transformer. The machine on mains is connected to the two top contacts of the synchronising switch and then to the transformer by means of two small switches. The secondary winding of the transformer is connected to a lamp and Cardew voltmeter in series. When the synchronising switch is in, the machines are in parallel through light fuses with the two choking coils. When the ammeter needles remain steady, the choking coils are short-circuited and the machine switch put in.

Bournemouth.—(Mordey.) A 50-volt secondary fed by a transformer across 'bus bars is put into series with a 50-volt secondary fed by a transformer on alternator armature, and a lamp for engine-driver and voltmeter for engineer; switching supplied in usual way. Engine is run up to speed on the stop-valve, machine voltage equalised to that of 'bus bars by use of a resistance in exciting circuit, and machine switched in when a steady co-phasedness is shown by synchronising voltmeter. The machine thus put in contributes no current to 'bus bars until the steam admission is increased, when it takes up its share of the load.

Kingston-on-Thames.—(Siemens.) The new machine is run up until its voltage, as shown by the machine voltmeter (common to all machines through a multiple D.P. switch), is similar to the voltage on the omnibus bar. It is then synchronised by means of a synchronising lamp and put into parallel. The E.M.F. of the machines can be regulated either by their speed or by means of the field-magnet resistance switches. These can be worked separately for any machine, or can be worked together when the machines are running in parallel by means of a worm gear.

Worcester.—(Mordey.) The field of incoming alternator is excited off low-tension 'bus bars (common to all four alternator fields), and exactly balanced by means of adjusting resistance in field circuit to allow for difference of temperature of field coils. Incoming alternator then speeded to 430 revolutions per minute as shown by tachometer, and a synchronising lamp shows exact moment to operate the D.P. switch and connect to high-tension 'bus bar. The machine is then given load by means of special adjustment on engine governor.

The details of those alternators obtained by Mr. Hammond are given in Table A. In the other cases the details did not include much beyond the output and speed of the machines.

I am sorry that the data set forth in Answer 21 is not more complete, as I am inclined to think that, given a well-built alternator mechanically and electrically, the secret of perfect parallel running is to be found in perfect turning moment, and perfect turning moment depends upon flywheel energy, steadiness of drive added to good governing. With regard to the last, my practice is to stipulate governors to run from full in to full out with 5 per cent. changes of speed, also an adjustable weight to vary speed by hand, 5 per cent to be provided. The governing arrangement such that the speed shall not vary more than 5 per cent. with 100 per cent. of the load thrown instantaneously off and on, with the stop-valve wide open, nor more than 2½ per cent. when changing over from condensing to non-condensing. With regard to flywheel energy, I may mention that in a recent specification I indicated 35 tons as a minimum for the weight of the field magnets of the alternator acting as a flywheel, with a centre of gravity at a radius of 10ft., and normal speed of the engine 100 revolutions per minute. With regard to three-crank *versus* two-crank engines, I should be inclined from the point of view of parallel running, to give the preference to the former, provided that good governing could be relied upon. At the same time, I must confess that the excellent results achieved last year at Leeds with rope-driven, slow-speed horizontal engines confirms me in my preference for that type of plant when space is available and coal is obtainable at a reasonable figure. I should certainly give it the palm so far as smooth running is concerned.

No paper on parallel running would be complete without pointing out that the lower the periodicity the easier the paralleling. I have already instanced the excellent paralleling at Ayr with a direct-driven plant running at 96 revolutions, whereas at Leicester it is a matter of common knowledge that perfect paralleling has so far not been attained by a direct-driven plant running at somewhat similar speed. May not the reason be that in the former case the periodicity is 60 and in the latter 100? It would be a great boon if there could be some standard periodicity settled upon as there has been practically a settled voltage for incandescent lamps.

INSTITUTION OF ELECTRICAL ENGINEERS.

The conclusion of the discussion on Thursday week on Mr. Addenbrooke's paper on high-voltage lamps and their influence on central-station practice could only be given very briefly in our last week's issue. The following gives at somewhat greater length the remarks of the speakers who succeeded Mr. Stearn.

Mr. Rose, in order not to prolong the debate, would only remark that he had found very little trouble in the manufacture of the higher-voltage lamps. His firm had supplied them to Wolverhampton, Manchester, and Bradford.

Mr. Snell said that at St. Pancras they were running lamps at 220 volts, and had had very little trouble with them; in fact, their consumers hardly knew the difference between the 200 and 100 volt lamps. If any trouble did occur, it was at the holder. With regard to steadiness of voltage, the Board of Trade allowed a 3 per cent. deviation. With 440 volts, it would be easier to maintain a less percentage deviation at the lamp terminals than with 220 volts.

Mr. Robertson said that, so far as his experience went, there would be no difficulty whatever in converting the whole of his firm's manufacture to 200 or even 300 volt lamps if it were required.

Mr. Geipel proposed to hand in his remarks for publication,

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He, however, contended that Mr. Addenbrooke's figures showed no advantage over the alternating-current system so far as first cost was concerned. The £60 allowed by him for the distributing mains on the 200 volt system was sufficient to cover the entire cost of the alternating station on the 100-volt system; and this with the station outside of the populous district, while Mr. Addenbrooke had his in the centre of the town It was a very great advantage to have the central station outside the town Not only was the site cheaper, but coal was more easily got and frequently water for condensing was available He thought there was no one in the room who would deny that 50-volt lamps could be run at a higher efficiency than 100-volt lamps, and 100-volt lamps at a higher efficiency than 200-volt ones. A great deal had been said about the life of 200-volt lamps, but in those trials what efficiency had they been run at? If a lamp was run at six watts, it would last for ever. Also, he would like to ask Mr. Stearn why he did not use his new method of strengthening the filament for making good 8 c.p. 100-volt lamps. With reference to the experience of Mr. Gibbings at Bradford, he would suggest that the consumers had not yet had their accounts, and that their satisfaction only referred to improvements in the pressure

Mr. Epstein, speaking on the subject of accumulators, said the figures given in the paper were borne out by his own experience. He thought the last word had not been spoken as to cheapening accumulators, and that further advances might be expected in this direction

Mr. Campbell Swinton wanted to know what the term "candle" meant in the efficiency tests. There were the English, French, and German candles, and they differed He was not referring to the difficulty of measurement, but simply to the standard adopted, as to which it was essential there should be uniformity.

Mr. W H. Patchell thought the consumer would expect to have his 200-volt lamps at the same price as he had paid for 100-volt lamps. At the present moment, if that were so, the company would have to supply them at a loss. With reference to what had been said as to the need of a better 8-c.p. 100 volt lamp, he himself had had no trouble with them, and he did not think that where there had been any trouble or difficulty with them they could have been run at a steady voltage.

Mr. Handcock said little had been heard on the subject from the consumer's side of the question. What was wanted was to know the efficiency of lamps at 200, 100, and 50 volts, and their efficiency at the end of 1,000 hours. So far as his experience went, he felt that at 100 volts the limit had been about reached. Complaints had been continually received about lamps, which really were due to unsteady voltage for the same lamps did exceedingly well when the voltage was regular. In speaking of the necessity of a steady voltage, the inventor of the incandescent lamp (Mr. Swan) had hit the right nail on the head. He (Mr. Handcock) thought the right thing was done by the New York company which included the cost of lamps in its rate and tested them in its laboratory. Again, he would like to ask whether, where the higher voltage was adopted it was the intention of the supply companies to charge for the current at such a rate that the consumer got the same amount of light for his money as he would with 100 volt lamps, because the change from 100 to 200 volts appeared to imply a change from a three-watt to a four-watt efficiency. His experience also showed him that at 220 volts there was liable to be trouble with the fittings even if these were the best that money could buy, but this could doubtless be overcome if the makers would remodel their patterns.

A suggestion was made that in certain cases it would be desirable, if it were possible to have lamps of less than 8 c p., and no other speaker rising, a written communication was read from **Mr. Baynes** who was unable to be present. This was mainly a recapitulation of the circumstances under which the change was made at Bradford from 115 to 230 volts. There were already over 15 stations in the United States working at the double voltage, which was a striking example of the much more cautious way in which a change was adopted in this country than in America. He considered that in his figures Mr. Addenbrooke had been unnecessarily liberal with his copper. With reference to the manufacture of lamps of higher efficiency at 100 volts, Mr Baynes pointed out that these lamps could be used on a 200-volt system wherever they could be run two in series—for instance, in all cases of shops and large rooms. Where the wiring was well done, there was less risk of fire in the higher-voltage system because the fuses were lighter. No trouble had been experienced with the switches. He preferred however, conductors in close proximity, and not in casing at arcing distance apart.

The **President** (Dr. Hopkinson) said there was time for him to make a few remarks as to their experience at Manchester At the town hall there they were working at 400 volts, for they had taken all five wires into the building, and were running as many as four lamps in series. In other buildings they had three wires, and ran lamps two in series, and they had had no trouble. As to leakage, it was admitted that there was some from the negative terminal as the middle wire was put to earth. That arose from bare copper being used. The leakage did not cause any inconvenience, though there was a certain loss of power. Bare copper was found so convenient that its use was being extended By the use of accumulators very great facility of regulation was obtained, since the limits were brought within that of one cell.

Mr. Addenbrooke said that such a very large number of points had been raised that he would not attempt to answer them that evening, but would send in his reply for publication. He must, however, acknowledge his indebtedness to Mr. Crompton for the help he had received in preparing his paper, and also to Mr. Scott, Mr. Callender, and Mr. Epstein. In the course of a conversation with Mr. Swan he had learned that the idea that there was a great demand for 8-c.p. lamps was a mistake. These did not really number much more than one-quarter of the 16-c.p. lamps. It was, he thought, a great pity that the practice should be continued of counting lights on the basis of an equivalent of 8-c.p. lamps, instead of 16-c.p. lamps. That was a practice that dated back to the early times, when people wished to show a large number of lamps on their circuit. It had also occurred to him as a curious thing that they had never had an intermediate lamp, say, at 150 volts, on the market. Such a lamp would have been useful for lighting factories, and they could be used in new installations and on alternating systems. Lamps at 150 and 160 volts were used in Austria, but here it appeared the change was to be made at one leap. In Edinburgh, Prof. Kennedy was going to change to 230 volts. Wandsworth was to have the double voltage, and Mr. Shoolbred had told him that Birkenhead was to have it. He was glad to have had the speeches of so many lampmakers, because engineers, as a rule, knew little of lampmaking. They did not wish to press hardly on the lampmakers, and, if there was any special difficulty, if the makers would tell the engineers what it was the latter would endeavour to get round it There was no doubt that the fluctuations of voltage were much greater than central-station authorities liked to acknowledge, but he thought that 200-volt lamps were less affected by a slight change in voltage than were 100-volt ones. He might mention a case that had occurred in testing some gas-engines The voltage had run up to 300 volts and the filaments had bent over like a piece of red-hot wire, but unless they happened to touch the glass they did not break. It was, of course, simply a mistake to suppose that the life of a lamp with two filaments was half that of a lamp with one. The life was simply that of the filament which went first. Mr. Addenbrooke then defended his figures from the remarks of Mr Geipel, and remarked that he really might have made them much more favourable, but had preferred to take outside figures. In many cases of alternate-current stations Mr. Geipel's figure of £60 per kilowatt was much exceeded Other remarks he would hand in.

At the close of Mr. Addenbrooke's reply the usual votes of thanks were passed, and the meeting adjourned to March 26.

MANCHESTER ASSOCIATION OF JUNIOR ENGINEERS.

The members of this society met on Saturday evening, the 7th inst., at their rooms in the Central Schools, Deansgate, to hear Mr. Albert Battersby (of the Manchester electric light station) read his paper on "Electricity Generating Stations," the president, Mr. Thomas Jones, M.I.Mech.E., in the chair.

Mr. BATTERSBY said that on January 1, 1896, there was a total of 139 electricity supply stations in this country supplying electrical energy. The total amount invested in this manner amounted to over eight million pounds, and this sum had been spent almost entirely for the supply of electric light. Little attention had been paid to supplying current for motive power, which was rather surprising, as it would find a good day load; and if electrical energy was sold at one penny per horse-power hour a profit would be made, and it would most certainly, in the author's opinion, be generally used for small powers. Reference was made to the modern electric lighting steam-engine, which must govern well at all loads from zero to full, and the governing must be prompt and sensitive. The speed of the engine must be sufficiently quick to make the governing prompt; the valve gear should be as simple and strong as possible, so as not to get out of order, and the valves set so as to work economically with an average load. A moderate-speed engine was recommended by the author, say, between 70 to 180 revolutions per minute. A full description of the boilers in use at the various electric light stations was next given, and the author spoke strongly in favour of the Lancashire boiler on account of its simplicity of construction, immunity from repairs, and its large steam and water spaces. Forced-draught apparatus was not necessary, in the author's opinion, except for the burning of poor fuel. Mechanical stokers, if of the "coking" type, were an advantage if there were more than four boilers. The author advocated the building of generating stations on the outskirts of towns so as to be capable of great extensions, as the majority of stations running would be altogether too small in a few years' time. High-tension alternating-current supply would be the most suitable if the area was a scattered one. Alternating-current arc lamps were not so good in light-giving qualities compared with continuous arcs. Another objection to this system was that a good self-starting alternate-current motor was not yet available, so that in a town where there was likely to be a demand for motive power a continuous-current supply must be adopted. A full description was given of the Manchester electric light station, for the illustration of which Mr. Wordingham, the city electrical engineer, had kindly lent apparatus, instruments, etc.

The lecture throughout was illustrated by a large number of diagrams and drawings, and at the conclusion a hearty vote of thanks was passed to the author for his interesting paper.

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THE PHYSICAL SOCIETY.

At the ordinary meeting, March 13, Prof. Carey Foster (vice-president) in the chair,

Mr. J. H. Reeves read a paper on "**An Addition to the Wheatstone's Bridge for the Determination of Low Resistances.**" The apparatus described can be used for measuring the resistance of metre lengths of wires of low resistance, the only additional apparatus required being a sensitive galvanometer, a Post Office form of resistance-box, and a metre bridge. It differs from the ordinary Kelvin bridge in that, instead of balancing by varying the length of the standard wire between the two contacts, the distance between these contacts is maintained constant, as is also the length of the wire which is being measured, and a balance is obtained by altering other resistances in the network. The author has made a number of tests which show that by his arrangement the resistance of metre lengths of copper wires between the limits of No. 22 S.W.G. and a stranded cable of seven No. 16's can be determined with an accuracy of 0·1 per cent. Mr. Reeves also read a note on the exact value of Matthiessen's standard.

A communication from **Prof. A. Gray** stated that the author had in his arrangement combined the fixed standard employed in Matthiessen and Hocking's modification of the ordinary bridge with the greater celerity of working arising from the smaller number of operations to be performed when the Kelvin bridge is used. Prof Gray thought that he, and probably others, had used a method similar to that of Mr. Reeves's, but that the paper was of great utility, since it showed how time may be saved and existing apparatus utilised.

Prof. Ayrton said that the advantage of the method described lay in the fact that it was independent of the resistances at the contacts In Carey Foster's method, however, the coils had to be interchanged, and inaccuracy might be introduced owing to the varying resistance of the mercury contacts. Unless the mercury-cups and the copper plates at the bottom were cleaned every day and the contacts reamalgamated, the resistance of the mercury-cups was very variable With regard to the question of Matthiessen's standard, it was to be remembered that the specific conductivity of copper had been steadily increasing. This increase was particularly noticeable in the copper prepared by the Elmore process, where during the deposition of the metal an agate burnisher is kept continually passing over the surface. Fitzpatrick had explained the rise in the conductivity of copper by supposing that the density of the copper now supplied was greater than that of the copper used by Matthiessen, and this explanation had seemed quite satisfactory. Mr. Reeves's experiments, however, have conclusively shown that this was not the true explanation ; it was now possible to obtain copper in large quantity having a conductivity of 103 on Matthiessen's scale.

The Chairman explained how, when using his method, the accuracy of the result depends, not on the elimination of the small resistances at the mercury-cups, but on the constancy of these resistances. Matthiessen and Dr. Russell found that the specific gravity of copper was apt to be low on account of the presence of dissolved oxide, and they were the first to pass hydrogen gas through the molten metal to remove this oxide.

Mr. Appleyard gave a simple diagrammatic sketch of the author's arrangement, and also pointed out that better results would probably be obtained with a galvanometer of one or two ohms resistance.

Mr. Campbell said that it ought to be definitely settled whether Matthiessen's standard was the conductivity per unit volume or per unit mass. Since copper was always bought by weight, he, as a practical man, strongly advocated the adoption of the mass conductivity ; further, in this case, the measurement of the specific gravity would be avoided.

Mr. Reeves having replied, a communication by **Mr. Puluj**, on "**Cathode Rays,**" was read by the **Secretary**.

Mr. Puluj contributed some Röntgen photographs taken by means of a form of Crookes tube which he had described in a memoir published in 1889. With this tube he has succeeded in obtaining impressions with exposures of only two seconds. Mr. Puluj considers that the particles of matter torn from the cathode, which convey negative electrostatic charges, by impact on the glass walls or on screens, equalise their electric charges, and in this process call forth, not merely a disturbance of the material molecules, but also of their ether envelopes Each portion of the glass or screen bombarded by the cathode stream becomes the starting point of ether waves, which, according to their oscillation period and oscillation character are either visible rays (phosphorescence) or invisible Röntgen rays The oscillations of the invisible rays may take place in a longitudinal direction, but no convincing argument had up to now been brought forward to support this view.

The **Secretary** also read a note on "**Permeability to Rontgen Rays,**" by **Messrs. Ackroyd** and **Knowles**. The authors have exposed a plate on which a number of pieces of metal, oxides, and sulphates were placed to the Röntgen rays in order to see whether the permeability of bodies to these rays depends on the atomic or molecular weight of the body. In each case it was found that the opacity increased with the molecular weight.

Mr. Blakesley said that he considered the Röntgen rays to be the propagation of electrostatic strain through space. With reference to the non-refrangibility of these rays, he had observed in one of the photographs exhibited by Mr. Swinton a dark line at the edge of the shadow of a wooden pencil which might have been due to the refraction of the rays by the wood. Mr. Blakesley had, however, found that this line was due to the varnish on the pencil. Some Röntgen photographs of quartz and ebonite rods, not only did not exhibit these dark lines, but there was a very slight indication of a bright line just on the edge of the shadow, which would indicate that the refraction of these rays was less in the rods than in the surrounding medium.

Mr. Edser exhibited some photographs taken with Mr. Jackson's form of tube, in which a concave cathode is employed Mr. Edser said that the whole of the tube on the cathode side of the anode plate phosphoresced. so that the Röntgen rays seemed to partake of the character of diffused light.

Prof. Ayrton said Mr. Jackson had found that the cathode rays formed a parallel beam, and did not first come to a focus and then again spread out.

Mr. Blakesley described the tube used by Puluj in which a mica screen coated with green calcium sulphide is placed between the cathode and the anode.

Mr. Gardner said the phosphorescence of the inside of the glass had been shown by Lenard to be due to electricity travelling round the inside surface of the glass.

In reply to **Mr. Pidgeon**, the **Chairman** said that Captain Abney had found that if the film was mounted on a ferrotype plate no action took place.

Prof. Perry said that he, for one, was of opinion that the Röntgen rays were undulatory. Prof. Larmor had given an explanation which seemed to agree with the observed facts. This explanation supposed that the intermolecular spaces respond to vibrations of a certain frequency. The reason no refraction or diffraction effects had been observed, was probably because of the extreme smallness of the wave-length of the undulation.

After some further remarks the society adjourned till March 27.

COMPANIES' MEETINGS AND REPORTS.

W. T. HENLEY'S TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Friday last at the Company's offices, Martin's lane, E.C., Mr. Sydney Gedge, M.P., presiding.

The **Chairman** in moving the adoption of the report, an abstract of which has been given in this paper, remarked that it was a very pleasant duty he had to perform in moving the adoption of so satisfactory a report and balance-sheet. There had been times when the Board had had to meet the shareholders and tell them that the dividends they were looking forward to were still in the future Those times had now passed. They began by paying 5 per cent., which was increased to 6 per cent., and they now recommended a distribution of 8 per cent. upon a statement of accounts of such a character that some of the shareholders might perhaps ask why they did not propose to pay 10 per cent. They had transferred £5 000 to reserve, as against £2 180 last year, and they had written off for depreciation £1,964, as against £1,000 They had also expended about twice as much as usual on the maintenance of their works which were in first-rate condition. Their volume of sales had increased by nearly 47 per cent. compared with those of the previous year, and this had not been owing by any means to any large submarine cable work giving them a large profit, but to the steady growth of their general business The balance of profit and loss account was £18,942, which was increased by the balance brought forward to £27 567. As he had said they could have recommended a larger dividend, but, after full consideration, the Board had come to the conclusion that it would be far more to the interests of the shareholders individually and to the Company as a whole to strengthen the reserve fund by the amount he had mentioned, and to carry forward a large balance - £13,367 The amount owing by the Company was £17 525, while the amount due to them exceeded that sum by £42,841. In keeping a large sum of money in the hands of the Company he was convinced that it would fructify there at least as well as an extra dividend would in the shareholders' pockets ; for he need hardly tell them that having ready money in hand and plenty of it, the Company were able to make their purchases on much better terms than if they had to give acceptances. The gross profit on the trading of the Company last year was £36,967, which had been earned at an expense, including directors' fees, of £14 176, or about 38 per cent. In the case of another company in the same way of business he saw that their gross profit was earned at an expense of about 48 per cent , and, as the shareholders were aware, the larger the gross profits the smaller should be the percentage of fixed charges. He therefore believed that the Board would be commended for their economical management The capital of the Company was £100,000 in ordinary shares and £30 000 in preference shares bearing 7 per cent , but the holders of the latter had the option up to July 2 next of giving six months' notice to convert them into ordinary shares He believed that the conversion would prove advantageous to the preference shareholders, while it would certainly be beneficial to the Company should they ever require, for the extension of their business, to raise further capital by preference shares. He therefore hoped they would give those notices and that the conversion would be effected. In reference to the workmen's dining-room and lavatory at their works, he might mention that these had not yet been erected because the negotiations for the closing of Victoria road and including it in the works were not yet completed. They hoped, however, this would be done during the present year.

General Hutchinson seconded the resolution for the report and

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accounts, and after some conversation, mostly of a complimentary characted, it was carried unanimously.

Resolutions were then carried for a dividend at the rate of 7 per cent. per annum on the preference shares and at the rate of 5 per cent. on the ordinary shares, making with the previous dividend one of 8 per cent. per annum free of income tax. The retiring directors and auditors were then re elected, and the proceedings closed with the usual votes of thanks.

OXFORD ELECTRIC COMPANY, LIMITED.

The general meeting of this Company was held last Friday at Oxford, Sir Henry Mance presiding.

The directors' report was as follows: "The revenue account shows a gross profit of £2,709. 8s. 3d. After providing for the full interest of 5 per cent. on the debenture issue and other interest, there remains £1,317. 9s. 4d., which, added to the amount brought forward from the previous year (£195. 4s. 8d.), leaves an available balance of £1,512. 14s. The directors recommend that a dividend of 3½ per cent be paid upon the ordinary shares, which will absorb £1,152. 11s., leaving £360. 3s to be carried forward to the next account. The running of the plant during the year has given entire satisfaction. Current has again been supplied to the public throughout the year without the slightest interruption. Since the last report 3,797 8-c p. lamps (or their equivalent) have been added to the system. On December 31 the number of lamps connected equalled 15,000 8 c p. lamps. Fifteen colleges are now connected to the mains, and the directors have every reason to hope that the increase in the number of lights during 1896 will be equally satisfactory. A new 150-h.p. engine and 100-unit dynamo of the same type as those already in use have been installed at the generating station and various additions made to the machinery and plant during the year. To provide for the anticipated increase in the demand for current, the directors are carefully considering the expediency of enlarging the works at Osney in accordance with the original design, and establishing additional sub-stations in various parts of the city. To provide for these extensions, the directors propose to issue 914 ordinary shares of £5 each. A new contract for the public lighting of the city has been entered into, the number of public lamps increased from 16 to 32, and the candle-power from 1,200 to 2,000 per lamp All the plant has been maintained in efficient order, and notwithstanding the high price of coal at Oxford, the expenditure of coal per unit of current delivered has been reduced to ·55d "

The **Chairman,** in moving the adoption of the report and accounts, said that at their last annual meeting he mentioned that the 1 per cent. they then paid on the ordinary shares was only an earnest of better things to come in the near future. He had that day to ask them to approve of the distribution of 3½ per cent on the ordinary shares. He was content to let the future speak for itself, but they could make a shrewd guess as to the probable requirements of the city of Oxford and the capacity of their works to meet those requirements. He did not presume to prophesy, but he could at least anticipate, and he might say that he had the highest opinion as to the future of the Company. They as directors might be permitted to congratulate themselves on the progress which had been made; at the same time they were not unmindful of the credit due to the system and to the whole staff.

Alderman Buckell seconded the resolution, remarking that the growth had been steady in the number of lights, and the current that had been supplied had been continuous, and the works had been conducted thus far without a single hitch or failure. He thought the history of the Company in this respect was almost unique in the history of electric companies in this country. They had, of course, the advantage of the experience of other companies, but they owed a great deal indeed to the system which had been inaugurated in the city, and a great deal also they owed to the efficient management of the Company by their chairman and by their engineer.

The resolution was carried unanimously.

BIRMINGHAM ELECTRIC SUPPLY COMPANY, LIMITED.

The annual meeting of this Company was held last week at Birmingham, Mr. H. Buckley presiding.

The **Chairman,** in moving the adoption of the report and accounts, a copy of which appeared in our last week's issue, apologised for the absence of Mr. G. S. Albright and Mr. J. F. Albright, members of the Board, who were abroad, and that of Mr. Holmes, the consulting engineer, who was unwell. The directors, Mr. Buckley said, were thoroughly satisfied with the progress of the Company during the past year. The issue of new shares to the amount of £50,000, authorised by an extraordinary general meeting, had been readily carried into effect. The premium was dealt with in such a manner that the item of preliminary expenses was wiped out of the balance-sheet, and further sums had specifically been placed against the cost of provisional orders. The reserve had been materially strengthened. The policy of reducing the price of light, which, of course, had materially affected their revenue at first, had been justified by the result. The loss in revenue had been overtaken by the increase in consumption, and the prospects for the current year, as shown by the returns for the first two months, were eminently satisfactory. They were not only getting fresh customers, but their present customers were increasing their consumption. The report of the Birmingham Old Library showed that last year, when the whole establishment was lighted by electricity, the cost, including repairs and renewals of lamps, was £75 9s 9d, against £77. 3s. 9d., the cost of gas for 1893. This result was attributed to the fact that the electric light was better distributed and could more readily be economised. The Birmingham Library was not the only concern in Birmingham that had had such an experience with the electric light. They had at the present time 20 miles of mains in the streets of the city, and there was a fairly steady increase both in the summer and in the winter consumption, while the increase in the number of lamps was quite steady.

Mr. J. H. Wilkinson seconded the motion, which was carried unanimously.

A dividend of 4 per cent was declared, and, in reply to a question, the **Chairman** said that they were unable to declare an interim dividend because during one half of the year their revenue was small as compared with that for the other half. Whether they would be able to do so in the future would depend largely upon the extent to which electromotors came into use in the city.

DOVER ELECTRICITY SUPPLY COMPANY.

The annual general meeting of this Company was held last week at Dover, Sir W. H. Crundall presiding.

The directors' report stated that on capital account the sum expended within the year amounted to £23,087. 19s. 8d, making with the expenditure of the previous year a total of £48,259. 1s. 6d. The revenue account for the year showed a loss upon the first nine months' working. This was largely due to the fact that the six months of lightest consumption—viz, from April till September—when the load was also abnormally light owing to the limited number of lamps then connected, were included, but in December the revenue about balanced expenditure and the directors believed that by the end of the current year the Company would be earning revenue in excess of working expenses. During the past year the generating station had been completed, the plant and machinery installed in complete working order, and the supply of current, commenced in April, 1895, was now continuously available by day and night for both lighting and power purposes throughout the whole of the main business streets, and in a considerable portion of the residential districts.

The **Chairman,** in moving the adoption of the report, said that no young company could expect to make a profit and declare a dividend on the first year's work. Their position, however, was most satisfactory, because, up to the present time, they had more than 5,000 8-c.p. lamps, or equal thereto, connected with their works. Having regard to the fact that with the present machinery they were only prepared to supply 10 000 8-c p. lamps, that position after the first 11 months' running was very good indeed. It showed that Dover had not been slower than other towns in adopting electricity and appreciating the great advantages to be derived therefrom. As to the cost of the current, the directors had seen their way to reduce that and to bring it almost down to the price of gas, and therefore they had done as much as could be reasonably expected, because they were giving a most luxurious light to the community. Gas spoilt the decorations of houses, and often injured health. If they saved their customers the cost of redecorating their houses, and gave a light that was pleasant and not injurious to health, it would be seen that in the long run electricity was the cheapest illuminant. Judging from the promises that the Board received, and the contracts entered into, they hoped soon to utilise the whole of the machinery—that is to say, that they would have equal to 10,000 8-c.p. lamps connected. When that occurred they would be in a position to declare a dividend. As to the prospect of having electric tramways at Dover, he believed that the whole town was in favour of electric trams, and the town would find it best in their own interests, and more economical to the ratepayers, to come to the Company for a price at which they could take current to drive the cars.

The resolution was seconded by **Mr. W. G. Lewis,** and after some remarks from **Mr. Van Tromp** on the subject of electric trams and motorcarts was carried unanimously.

EASTBOURNE ELECTRIC LIGHT COMPANY.

The annual meeting of this Company has been held at East bourne, Mr. J. G. Langham presiding.

The **Chairman,** after expressing his regret at the absence of Mr. George Boulton, the chairman of the directors, owing to ill-health, then moved the adoption of the report and accounts for the year ending December 31 last, and congratulated the Company on the business done. There had been an increase during the year of two arc lamps and 2,150 incandescents, making the total lights in circuit 37 arc and 14,206 incandescents for terms of 8 c.p. The revenue account showed a gross profit of £3,182. 2s., and, after adding £400 to the depreciation fund and paying debenture and other interest, they had £1,656 available for dividend. Last year they started a reserve fund with £300. To this they proposed to add another £300, making £600, and there would be enough not only to pay a dividend of 7½ per cent., the same as last year, which would absorb £798. 15s., but to carry forward £557. 5s. Last year the balance carried forward was £441. With the £400 added this year their depreciation fund amounted to £2,225. They had laid a new boiler in during the year, but regarding it as an addition to their plant—a necessary addition in consequence of the increased demand for the electric light—they would charge it to capital. Reviewing the history of the Company since its incorporation in 1882, the Chairman mentioned that the receipts in each successive year had been as follows: £1,140, £1,912, £2,611

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(two years). £2,173, £3,497, £4,053, £4,539, £6,753 (a year and a quarter), £4 549, £5 216, £5,910, £6,713. In 1892 they paid their first dividend, 3 per cent.; in 1893 they paid 5 per cent.; in 1894 they paid 7½ per cent.; and this year they were in a position to pay the same amount. There were at present no less than 16 miles of pipes laid down in 11¼ miles of street in Eastbourne, and there were 11¼ miles of double cable and 3½ miles of single cable, making a total of 26 miles of cable in the town.

The motion was seconded by **Alderman Sutton** and carried.

Mr. Hollins was chosen a director in place of Mr. Sutton, who declined re-election.

ROCKHAMPTON GAS AND COKE COMPANY, LIMITED.

The directors' report submitted to the half yearly meeting held at Rockhampton, Queensland, on February 11, stated that a marked improvement had evidenced itself in the consumption of gas as compared with the preceding half-year, but the total quantity consumed is considerably below that of former years. The gas operations showed a profit of £1,926. 2s 4d. There had been a slight drop in the quantity of electricity supplied during the half-year. Adhering to the principle established from the date of the introduction of electric light into the Company's business, care had been exercised to avoid a too rapid development to avoid an unnecessary clashing with the gas interests. Owing to the small number of new installations, and the consequent reduction in the profit derivable from the sales of fittings, the electrical operations did not show as advantageously as for the preceding half-year. As several new electric light consumers had been added to the list, and the general expenses were likely to be considerably reduced, the prospect for the current half-year in this department was encouraging. To minimise expense, and to enable the electric light operations to be worked more economically, and also to secure a reserve of electrical energy, the directors were importing a large set of accumulators, and they expected these to be in operation towards the end of the current half year. The electrical operations showed a profit of £219. 10s., which had gone towards the payment of debenture interest amounting to £300, charged to the electric light operations, leaving a difference of £80. 10s. represented in the debit balance of the profit and loss account of this section of the Company's business. The net profit for the whole of the Company's business was £1,845. 12s. 4d., and from this the directors recommended the payment of a dividend at the rate of 7 per cent. per annum upon the ordinary shares and 9 per cent. per annum upon the preference shares, and carrying a balance of £183. 12s. 8d. to next half-year. The report is signed by Messrs. Henry Jones (chairman), F. Clewett (director), and William Spier (secretary and general manager). The usual accounts are appended, from which it appears that generating current cost £542, and sales of current realised £818. The reserve fund for maintenance of plant stands at £2,289 and there is also a small reserve of £291 available for equalisation of dividends. The total of the capital account is £61,771.

IMPROVED ELECTRIC GLOW LAMP SYNDICATE.

A meeting of this Company was held on Saturday at the Cannon-street Hotel, E.C., but the Press were not admitted.

LEGAL INTELLIGENCE.

ELECTRIC LIGHTING LANTERNS.

In the Chancery Division, before Mr. Justice North, on Friday, 13th inst., an application was made in the case of Clarke *v.* Sax on behalf of the plaintiff, John Farrand Clarke, for an interim injunction against Messrs. Julius Sax and Co., Limited, to restrain them from infringing the plaintiff's copyright in a registered design for lanterns used for electric lighting.

Mr. Swinfen Eady, Q.C., and Mr. Metcalfe (instructed by Mr. H. Stanley Sugden) appeared for the plaintiff, and Mr. Vernon Smith, Q.C., and Mr. Church represented the defendants.

It appeared that the defendants held a concession from the Corporation of the City of London to supply electric lighting to the Central Meat Markets, and that the plaintiff was the owner of a registered design invented by him for electric lighting, and that the defendants had used lanterns which were a colourable and obvious imitation of the plaintiff's lantern. The defendants contended that there was a difference between the two.

Mr. Justice North gave judgment for the plaintiff, and granted the injunction.

DOLBEAR'S PATENT.

At a sitting of the Judicial Committee of the Privy Council on Wednesday (present Lord Watson, Lord Hobhouse, Lord Davey, and Sir Richard Couch), the decision was given in the case of a petition for prolongation of letters patent granted to Mr. Amos Emerson Dolbear, of Somerville, Massachusetts, bearing date March 21, 1882, No. 1,368, for an invention of "Improvements in Electrical Cables."

Mr. Moulton, Q.C., Mr. Bousfield, Q.C., and Mr. J. C. Graham appeared for the petitioners, who were Mr. Amos Emerson Dolbear and the British Insulated Wire Company, Limited; Mr. Cripps, Q.C., Mr. Roger Wallace, Q.C., and Mr. A. J. Walter for opponents; and the Attorney-General and Mr. Sutton for the Crown.

The invention related to the insulation of electric conductors, and consisted in reducing to the smallest possible extent the contact between the conductor and the surrounding insulating material. The British Insulated Wire Company, Limited, became the owners of the letters patent in September, 1895. The petition stated that at the date of the letters patent—viz., 1882—there was little or no need for cables made according to the invention. Now, however, that large numbers of insulated wires for telephonic purposes were laid in the form of cables in troughs or pipes in the ground, and cables insulated according to the invention had been found to be of great value for this purpose. Owing to the above causes the invention did not come into any commercial use until quite recently.

Lord Watson pointed out that no effort was made to push the patent commercially until 1892. Their Lordships would advise her Majesty that the prayer of the petition ought not to be granted, and would direct that the caveators should have one set of costs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Aberdeen.—The Corporation invite tenders for an additional engine of 300 h.p. at the electric lighting station.

Prague Austria).—Tenders are wanted by June 1 for an electric lighting central station for the city of Prague. Application should be made to the Stadrath, Prague.

Paris.—On April 9 there will be a limited competition at the Hotel de Ville for the supply of eight standards for the electric lighting of the Quai de Jemmapes and the Quai de Valmy.

Aston Manor (Warwickshire).—The Urban District Council require tenders for a high speed vertical engine and dynamo for the improved lighting of the baths. The estimate is £350.

Duisburg (Germany).—The Municipality require tenders before March 23 for the electric lighting work for their new swimming-bath. Particulars can be obtained for 2 marks (2s.) from the Stadtbaurath, Duisburg.

Elberfeld.—Tenders are wanted by April 20 for the supply of four engines and dynamos and 174 lamps, conductors, etc, for the Prussian State Railways Address, die Königliche Eisenbahn-Direktion, Elberfeld, Germany.

Halle-a.-Saale.—Tenders are required by March 24 for the supply of pine wood telegraph poles for the State Railways. Particulars at the office of the Konigl. Eisenbahn Direktion, altes Bahnhofs-gebäude, Halle a.-Saale.

Zamora (Spain).—Tenders are wanted by March 30 for the concession of the electric lighting of the town of Zamora for a period of 40 years. Particulars can be obtained from the Municipal Authorities. A security of 4,000 pesetas (£160) will be required.

Paris.—Tenders are required for the supply of pipes, tubes, and sheets in copper and brass for the arsenal at Haiphong (French East Indies), in two lots. Specifications and particulars at the Ministry of the Colonies, Paris, and at the Chambers of Commerce at Paris, Marseilles, Bordeaux, Nantes, and Havre.

St. Pancras, N.W.—The Vestry invite tenders for additional plant at the King's-road central station—viz, three engines, necessary dynamos, steam-pipe connections, switchboard, and other apparatus. Particulars are given in our advertisement columns Tenders to the chief clerk, 57, Pratt-street, Camden Town, N.W., by 12 noon on 26th inst.

Brunn (Austria).—The Municipality desire offers for the construction and working of a central station for the supply of electric energy for lighting the town, for power, and, if required, for running a tramway. Tenders must be sent before March 31 to the Bürgermeister, Brünn, Austria, from whom particulars can be obtained.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grange town, Yorkshire, to whom the plans, etc., must be sent by May 1.

Edinburgh.—Tenders are required by the Corporation for the wiring of the City Chambers. Specification, forms of tender, and plans of the building can be obtained at the office of the resident electrical engineer, 5, Dewar-place, Edinburgh, on deposit of £2 2s., which deposit will be returned on receipt of a bona fide tender. Tenders must be sent to Mr. Thomas Hunter, W.S., town clerk, by 10 a.m. on 28th inst.

Lima (Peru).—Tenders for the electric lighting of the city of Lima will be received up to June 1 next at the Peruvian Legation, 13, Comeragh-road, West Kensington, W., where applicants can obtain a memorandum explaining the local conditions. The tenders will be opened and considered by the Municipality of Lima, which reserves to itself the right of selecting that which is most approved or rejecting all if it thinks fit.

Brussels.—Tenders are wanted for the supply of a large quantity of stores and fittings and apparatus (12 lots) for electric lighting. Specifications and particulars can be obtained at the

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Brussels Bourse, and tenders must be in by March 25. In the various lots are included copper wire, commutator brushes, mica, cables, platinum wire, phosphor bronze, ebonite, arc lamp globes, incandescent lamps (various voltages and patterns), armoured cables, etc.

Shoreditch, E.—The Vestry require tenders for engines, electric generators, switchboards, pumps, steam and water mains, cast-iron work, motor transformers and accumulators. Specifications, etc, can be obtained on and after 23rd inst., of the consulting engineers, Messrs Kincaid Waller, and Manville, 29, Great George-street, Westminster S W, on payment of £3. 3s, which will be returned on the receipt of a bona fide tender. Tenders, endorsed "Tender for Contract No 4" to be sent in by 4 p.m. on April 14. Further particulars will be found in our advertisement columns.

Bedford.—The Electric Light Committee invite tenders for the supply and erection of the following plant: (Section A) one 240-b h p double-acting compound enclosed engine, (B) one 150-unit alternator, with stationary armature. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. T. S Porter clerk to the Urban Sanitary Authority, Town Hall, Bedford, on payment of a fee of 5s. for each section. Tenders sealed and marked "Electric Lighting, Section A or B" must be delivered to the clerk by April 4.

Chesterton (Cambs).—The Urban District Council are open to receive tenders for the public lighting of the district for seven years The tenders shall be made in the three following modes—namely, (*a*) lighting the district from August 14 to May 15 (inclusive) in each year; (*b*) lighting the district throughout the whole year commencing May 15 next; (*c*) lighting the district for either of the above periods (1) with ordinary burners, (2) with incandescent burners, if the illuminant with which the tender be made be gas. All cleaning, lighting, and maintenance to be done by the contractors Tenders to be sent to Mr James Spearing, clerk, 15, Sydney-street, Cambridge, by March 31.

Egremont.—The Wallasey Urban District Council require tenders for the following requisites—viz.: (a) steam alternators, switchboard, and accessories; (b) high and low tension concentric cables; (c) transformers. Copies of the specifications may be obtained on application to the engineer, Mr. J H. Crowther, Gas and Water Works, Great Float, near Birkenhead. A charge of £2. 2s. will be made for copy of each specification, to be returned on receipt of a bona fide tender. Sealed tenders, on the form to be provided for the purpose, addressed to the chairman of the Gas and Water Committee, and endorsed "Tender for Steam Alternators, Switchboard, and Accessories," or any other contract, as the case may be, to be delivered at the office of Mr. W. Danger, clerk, Public Offices, Egremont, by 4 p.m. on April 6. Each contractor will be required to enter into a bond with approved sureties for the performance of contract.

Antrim.—The Commissioners for the Control of Lunatic Asylums will receive sealed tenders up to 10 a m. on May 1 for the supply and erection of an electrical installation at County Antrim Lunatic Asylum. The tender should be sent in a sealed envelope, endorsed outside "Tender for Electric Lighting, County Antrim Asylum," and addressed to the secretary, Board of Control, Custom House, Dublin, and should be accompanied by a separate sealed envelope, similarly addressed and endorsed, containing the detailed estimate. Forms of tenders, and copy of specification, which has been prepared by Mr. J H. Greenhill, M I E E, will be issued on application to the office of the Board of Control of Lunatic Asylums, Dublin, on deposit of £3, which will be returned to all persons who have sent in bona fide tenders. Plans can be seen at the office of the architect, Mr. John Lanyon, Northern Bank-chambers, Royal-avenue, Belfast.

Bucharest.—The Communal Council require tenders for lighting the suburban districts of the city by some system which shall not require to be conveyed underground by means of pipes or otherwise, and which shall, in the opinion of the Board, be considered the most advantageous of all the systems submitted, with a view to substituting same for the 3,265 oil lamps now used for lighting the suburban streets and squares. The contract shall be given in accordance with the specification relating thereto, which has been drawn up by order of the Board of Technical Works, and approved by the Communal Council at a meeting held on January 24 The specification may be inspected any day during business hours at the office of the Agence Havas, 96, Queen-street, Cheapside, London, E C. The contract to be given for a term of five years from April 1-13, on which date the present contract runs out. Sealed tenders will be received from the 14th to 26th inst. Applicants must, in their tenders, refer to the items provided in Article 6 of the specification. All persons desirous of tendering are requested to attend at the Mairie on the day and hour above mentioned and lodge security for 15,000fr., failing which they will not be allowed to tender. The tender to be governed by Articles 68-79 of the General State Accounts Act.

Bradford.—The Corporation invite tenders for the following plant and machinery—viz.: (1) batteries: (2) surface condensing plant; (3) cables; (4) travelling crane; (5) steam and exhaust pipes. Forms of tender and specifications may be obtained on application to the electricity office, Town Hall, Bradford, on paying a deposit of £1 for each specification, which will be returned on receipt of a bona fide tender. Tenders, to be endorsed "Tender, Electricity Works," and addressed to the chairman of the Gas and Electricity Committee, and delivered at the town clerk's office, Bradford, by 25th inst. An assurance must be given by each contractor that he pays to the workmen employed by him not less than the minimum standard rate of wages. The Corporation also invite tenders for the erection of a building required for the new electricity station at the junction of Valley-road and Lionel-street in the borough. Plans and specifications may be seen and bills of quantities obtained, free of charge, on application to Mr. Thomas Barker, A.M.I.C.E., architect at his offices, 5, Bond-street, Bradford, on and after 25th inst. An assurance must be given by each contractor that he pays to the workmen employed by him not less than the minimum standard rate of wages. Tenders, endorsed "Tender—Electricity Works," to be sent to Mr. W. T. McGowen, town clerk, Town Hall, Bradford, by April 8.

RESULTS OF TENDERS.

Dewsbury.—The Town Council have accepted the tender of Messrs. Chadwick and Son for the supplying and fixing of an electric fan for the Turkish bath department and the constructing of an upcast shaft at a total cost of £20. 10s.

Namur.—The lowest tender for the construction of a telephone service building at Namur (March 10) was that of Messrs. Dandumont, of Namur, at 86,949fr. The highest was from Messrs E. Heine, of Huy, at 102,500fr. The estimate was 83,605fr.

Tunbridge Wells.—The tender of Messrs. Johnson and Phillips to supply a Willans engine at the central electric station for the Town Council, at £750, has been accepted. The Town Council have also accepted the tender of Mr. J. Jarvis for the extension of the electric lighting station at £1,356.

Durban (South Africa).—The Corporation have accepted the tender of Messrs. Andrew Handyside and Co, of Derby, for 70 cast-iron junction-boxes 400 cast-iron service-boxes, 70 cast-iron manhole frames, etc., covers, and 100 spare porcelain blocks, and 100 blank flanges for the electric lighting of the town.

BUSINESS NOTES.

Dorset.—The electric lighting of the new asylum has cost £2,000.

Dundee.—The committee are introducing electric lighting into the Scottish Liberal Club.

Portsmouth.—A new electric shop has been commenced on the site of the old convict prison.

South Staffordshire Tramways Company.—The receipts for the past week show an increase of £55.

Newcastle.—The City Council have voted a sum of money to provide for the electric lighting of the town hall.

Aberdeen.—A deputation of the Harbour Board have visited Liverpool to inspect the system of electric lighting at the docks there.

Railway Accident Insurance.—£1,000 tickets are now issued at all stations for all classes by the Railway Passengers' Assurance Company, 64, Cornhill, London.

Gravesend.—At the Town Council meeting the surveyor reported that the telephone to the sanatorium was now completed and in satisfactory order.

Matlock.—Accommodation has been provided at the town hall for an exchange for the National Telephone Company. The trunk line has reached the town.

Southend.—The Town Council are going to light the western esplanade, and a committee are considering the question of adopting the electric light.

Bangor.—A lengthy and detailed reply to the statement of the committee on the electric light question has been sent to the Board of Trade by the opponents of the scheme.

Richmond.—Upon the recommendation of the Electric Lighting Committee, the Town Council have approved of the plan from the electric lighting company to extend their area.

Cardiff.—The borough surveyor has been instructed to report on the lighting of Canton Bridge and of various streets. The public lighting is now costing something like 3½d. in the £.

Portrush.—The County Antrim Grand Jury have approved a proposal that the Giants' Causeway electric tramway should change the present system of electric traction to the overhead system

Coventry.—Mr. R Hammond, consulting engineer to the Corporation, suggests the laying down of a new set of plant of 400 i.h p, 200-kilowatt capacity, at an estimated cost, with additional cables, of £8,900.

Aberystwith.—At the Town Council meeting the Public Lights Committee recommended the Council to pay the electric lighting company £803. 19s, being the cost of arc lamps and pillars. The recommendation was adopted.

Sandycroft.—At the annual parish meeting the question of electric light cropped up, and it was suggested that they might erect a generating station of their own, with an oil engine and dynamo, near the centre of the village.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending March 15 amounted to £1,095, as compared with £975 in the corresponding week of the previous year, being an increase of £120.

Lytham.—At the meeting of the Urban Council a letter was read from the engineer to the tramway company asking for permission to be allowed to run two cars together. It was resolved that the request be not acceded to.

Chester.—At the meeting of the Town Council it was decided that the present arrangement with the gas company for lighting the

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city should continue for six months instead of 12, having regard to the installation of the electric light.

Bradford.—The Gas and Electricity Supply Committee of the Town Council have passed the plans for the erection of new electricity works for the Corporation in Valley-road, and steps were taken for at once obtaining tenders for the work.

Ballymena.—The Town Commissioners have decided that there should be a telephone wire connecting Ballymena and Belfast, and they have instructed the clerk to write to the National Telephone Company and postal authorities in regard to it.

Ulverston.—The Rural District Council have acceded to the application of the Windermere and District Electricity Supply Company for an extension of time to carry out their obligation in regard to the deposit to be made with the Board of Trade

Electric Light in Hyde Park.—Among items which appear in the Civil Service estimates this session for the first time is a charge for the electric lighting, not only of the bandstand in the park, but also of the footpath between the Marble Arch and Albert Gate.

Brighton.—The Lighting Committee of the Corporation have decided to recommend the erection of electric arc lamps in Preston road, between Springfield-road and Stanford-avenue, and in Stanford avenue, between Preston-road and Beaconsfield-villas.

Ringwood (Hants).—At the District Council meeting an application from the Telegraph Department at the Post Office for permission to erect a telegraph wire at the side of the highway from Burley Post Office to the railway at Whitton Bridge was granted.

Kensington (London).—At the meeting of the Vestry a letter was read by the clerk from the Notting Hill Electric Lighting Company forwarding copy of the directors' report and accounts of the company to December 31, 1895. The letter was referred to committee.

Warminster.—The Urban Council has considered the question of the lighting of the lamp over the fountain both with electric light and the incandescent burners, and has decided that as the light nights were coming on the matter remain in abeyance for six months.

Londonderry.—Mr. Christie, electrical engineer, has reported on the recent failure of B and D circuits. He states that the cable faults were not due to any latent defect, but the cables had evidently been damaged by picks when the ground was opened for service pipes.

Post Office Estimates.—The sum of money provided in this year's estimates of the revenue departments for the pay, rent, and office expenses of the local post offices in England and Wales is £3,650,336, being £2,679,690 for postal work, and £970,636 for the telegraph service.

Dewsbury.—A discussion took place at the meeting of the Town Council as to whether the arc lamps should be lighted or not on Sundays. The committee in their report did not entertain the suggestion, and the Council eventually upheld their view despite considerable opposition.

Leeds.—The exterior of the new town hall will be lighted by seven arc electric lamps. They are to be fixed to standards set in the footpath, and will extend along the building from Norfolk-street, along New Surrey-street, and as far as St. Paul's Church gates in Pinstone-street.

Ashbourn.—The promoters of the Derby and Ashbourn Tramways Bill have officially notified the abandonment of this Bill for the present session. The proposed tramways were intended to be worked upon the overhead trolley system. The total cost of the tramways was estimated at £31,172.

Ashton-under-Lyne.—The Town Council have consented to the application of the promoters of the proposed Oldham, Ashton under Lyne, Hyde, and district electric tramways for a provisional order authorising the incorporation of a company and the construction and maintenance of tramways.

The Isle of Man Tramways.—At an extraordinary general meeting of the shareholders of the Isle of Man Electric Tramway Company sanction to purchase the Snaefell Mountain Railway for £72,500 was unanimously confirmed, and it was decided that the capital of the company be increased to £175,000.

Leicester.—The electric lighting department accounts show a deficiency on the half-year, after providing for interest and sinking fund, of £185. 7s 2d., which is a considerable improvement on the previous half-year, and is considered very satisfactory seeing that it has only been established one year.

Bourg (France).—The River Ain having overflowed it banks, a dam at Oussiat, near the Joly Electric Works, was carried away. At Pourcin, a manufacturer was proceeding to his machinery-house in a boat, with his engineer and two electricians, when the craft was capsized, two of its occupants being drowned.

High-Voltage Fittings.—The Edison and Swan Company inform us that, in order to meet the present requirements for fittings of a high insulation for high-voltage currents, they are now ready to supply switches, cut-outs, and holders with patent enamel liners. Sample Tumler switches are on view at their offices.

Williamson and Joseph, Limited.—This Company has been registered by M. Moseley, 303, Strand, with a capital of £10,000 in £1 shares, of which 5,000 are 5 per cent. cumulative preference, in order to enter into an agreement with E. L. Joseph, and to carry on the business of electrical engineers and electricians in all its branches.

Radcliffe.—The surveyor has reported to the District Council that the possible users of electrical energy within 200 yards of the lines to be laid down in the compulsory area were as follow; lamps, 182; shops, 185; beerhouses, 17; public-houses, 7; dwelling-houses, 1,246; mills, workshops etc., 23; and churches, chapels, schools, etc., 15.

City and South London Railway.—The returns for the week ended March 15 were £949, compared with £912 for the corresponding period of last year, being an increase of £37. The total receipts for the half-year terminating as above were £10 786, compared with £10 823 in the same period of the preceding year, being a decrease of £37.

Godalming.—The Board of Trade have issued a provisional order (with a view to the same being included in a Confirmation Bill, about to be introduced into Parliament) authorising the Corporation to supply electrical energy for all public and private purposes as defined by the Electric Lighting Act, 1882 and 1888, within the whole of the borough.

Hove (Brighton).—The Fire Brigade have asked the Urban Council to take into consideration the question of establishing a system of electric fire alarms for the better protection of the town. The resolution has been referred to the surveyor and the chief constable to report on the practicability of carrying out the suggestion, and the cost of doing so.

Fleetwood.—The Urban Council have given their consent to the Blackpool and Fleetwood Tramroad Bill, and they have sanctioned an extension of the time for purchase of the tramway by the local authority from 21 to 30 years, but, on the other hand, the time for completing the construction of the works has been reduced from five years to three years.

Southampton.—The Works Committee recommend the Corporation to purchase the undertaking of the Southampton Electric Light and Power Company, Limited, for the sum of £21,000, and that application be made to the Local Government Board for a loan of £50,000 to complete the purchase and to carry out the necessary extensions of the undertaking.

Morecambe.—The District Council have appointed a sub-committee to look out for a site for electrical works for supplying electric light, suggest a scheme for supplying the light, and prepare the application to the Board of Trade and the Local Government Board, with power for the sub-committee or some of them to visit such electrical works as they may think advisable.

Birmingham.—The committee of the Medical Institute, in submitting their report for the year 1895, record the installation of the electric light in the library and reading-room. It has not been in use long enough to enable a full statement to be made as to its cost as compared with gas, although, so far as can be judged from a three months' trial, it seems likely to effect a distinct saving.

Douglas (Isle of Man).—A correspondence has been going on in the local Press as to the relative cost of the electric light and gas. Mr. E Berry champions the cause of electricity and quotes the "Town Councillors' Handbook to Electric Lighting" to prove his statement that for 6d. (the average charge for the unit) one can be supplied with current to light between 33 and 40 8 c.p. lamps for one hour.

New Company.—The Cottonwood Water Power and Electric Company, Limited, has just been formed, with a capital of £210,000, for the purpose of acquiring the waters, waterfalls, reservoir sites, and lands necessary for the operations of the Company of and in the Little Cottonwood Creek, situated near Salt Lake City, Utah, U.S.A., and of erecting a water-power plant for the supply of electrical current.

Walsall.—At the meeting of the Town Council the Electric Lighting Committee reported that the total number of consumers was 52, and that the income during February amounted to £120. 10s., less 2½ per cent. for prompt payment. The Ex-Mayor, in answer to a question, said the committee had decided to lay the mains on to the public baths, and would be glad to extend the mains to any part of the town from which there was guaranteed a remunerative return.

The Copper Market.—Stocks of copper in England and France, including shipments advised from Chili and Australia, are shown in Messrs. Henry R Merton and Co 's circular to have decreased by 2,406 tons between February 29 and March 15, but during the same period the quotation for G.M.B.'s has declined from £46. 10s. to £44 17s. 6d. The quotation is, however, about 12s. 6d. higher than it stood at a month ago, and very considerably above that ruling at this time last year.

Yarmouth.—The electric supply accounts for February show that the receipts exceeded working expenses by £80. 2s. 9d., but the charges for repayment of capital, interest, rates, and insurance amount now to £100 per month. Five more customers have been obtained for 350 lamps, making the total 150 customers for 6,997 lamps The surveyor has been directed to lay mains, etc., on the North Quay as soon as customers had been obtained in the district to the extent of £50 per annum.

New Electric Pump.—Messrs. Merryweather and Sons have just supplied for Lord Rothschild's mansion in Piccadilly a new treble-barrel pump of novel construction, driven by an electric motor, to work as a pressure augmentor on the fire-main system. The driving current is taken from the electric lighting system, and the motor drives the pump direct and works silently. This pump is also to be seen at work at the firm's Long-acre house, and is suitable for water-supply work, as well as for fire extinction.

Islington, N.—In our description of the Meldrum blowers at the electric light station the statement that "the furnaces can burn 40lb. of fuel per square foot of heating surface" should have read "per square foot of grate surface." At the Vestry meeting the clerk reported that he had received a copy from the Board of Trade of

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new regulations with reference to electric lighting to ensure the safety of the public and ensure proper and sufficient electrical energy. The matter was referred to the Electric Lighting Committee.

Edinburgh.—A sub-committee of the Edinburgh Town Council has had under consideration the application of the National Telephone Company for permission to lay underground wires in the city. The meeting instructed the town clerk to ascertain precisely the position taken up previously by the Town Council on the telephone question, and also the obligations which Edinburgh was under to Glasgow in connection with the subject The Town Council have passed a resolution which finally commits them to the cable system for their tramways.

Chiswick.—At a special meeting of the District Council the clerk reported, in reference to the agreement with the Duke of Devonshire as to the electric lighting works and dust destructor, that the Law and Parliamentary Committee had inspected the document and was not satisfied as to the clause relating to nuisance. The Duke's agents, on the other hand, declined to waive the clause. He had offered them a general clause as to nuisance, but they would not accept it. The agreement was referred back to the Law and Parliamentary Committee.

Electric Lighting in India.—There are several schemes afloat for introducing electricity in Bengal. The project for lighting Darjeeling has, it is stated been accepted by the Commissioners. In Calcutta, besides the Seebpore College lighting scheme and that for the Alipore Jail and Belvedere, the main project for lighting a portion of the city is being taken up by several firms, including Messrs. Martin and Co., but the acceptance of a scheme or schemes for general lighting depends upon a complete procedure being laid down under the Act, steps for which are in progress.

Dover.—The Town Council have received the revised Board of Trade regulations to provide for the safety of the public in regard to electric light. The electric light company have written in reference to the lamps from the Market-square to the sea-front, pointing out that the column proposed was not applicable to arc lighting, and also that the light was better distributed on the higher columns, and they produced statistics from 14 other towns showing that the height of the columns was generally higher than in Dover. The matter has been referred to the Lighting Committee for report.

Taunton.—At the meeting of the Town Council the Electric Lighting Committee presented the statement of the accounts for the year ending December 31 last. The committee reported that the laying of the cables and other works in connection with the No. 3 sub station was progressing satisfactorily. Alderman Potter, in moving the adoption of the report, said it must be satisfactory to the Council to learn that during the last 12 months they had only drawn £350 from the rates, as against £1,100 during the previous 15 months. Councillor Sibley seconded, and the report was adopted.

Catalogues.—We have received the complete catalogue of the Electrical Company, Limited, of 122 Charing Cross-road, W C. The first half of this, dealing with dynamos and motors, was noticed by us some time ago. The second part deals with the "Luna" arc lamps, measuring instruments, switches and fittings, carbons, incandescent lamps, and electric bells The two parts are bound together in green cloth, and provided with a thumb index. We have also received from Messrs. Cutting Bros, of Parliament Works, Derby, their price-list of continuous-current dynamos and motors.

Dublin.—The Master of the Rolls has refused a motion for an injunction to restrain the Corporation from attaching their seal to a resolution, passed at their last meeting, giving the Southern District Tramway Company permission to extend their lines into the city from Haddington road to Carlisle Bridge The Southern District Tramway Company is mainly, if not entirely composed of the financiers who are working the Bristol tramways system The tramway lines in the city and running out to the suburbs are owned by the Dublin United Tramway Company, and a sharp rivalry is maintained between the two companies

Grimsby.—At a meeting of the Public Lighting Committee, the Chairman brought forward the question of the electric lighting of the borough. In 1894 they obtained from the Local Government Board a provisional order, but unless something was done in regard to the lighting it would terminate on July 3 of this year. There would be really no difficulty at all in getting the money. They would be very large consumers themselves, for it now cost the borough every year for gas £3,389 one-fourth of the last rate of £15,000. A good many residents in the town had already made use of the light. After some discussion, a sub-committee was formed to investigate the question.

Hampstead (London).—The Vestry have appointed Mr. Hudson, as the architect, to prepare plans and specification for the necessary additions to the electric lighting station and to superintend the carrying out the work. The resignation of W. Bathurst, assistant electrical engineer, was received and accepted. The following are the surveyor's estimates for the lighting account for the ensuing year: gas for public account, £6,300; electric lighting, Finchley-road, £1,014; removals and repairs, new lamps and services, £200; interest and principal (electric lighting loans), £3,008; working expenses (central station), £6 000; proportion of establishment expenses, £414—total, £16,936.

Manchester.—Three youths, named William Sidley, Percy Pattinson, and Thomas Ball, were charged at the police court last week with damaging telephones at Reddish, on March 1, by throwing stones at the insulators on telephone posts Defendants were each fined 5s., or seven days. In reply to a statement recently published, the general manager of the National Telephone Company writes to the *Manchester Guardian* to make it clear that subscribers to what Mr. Wm. Thomson called an "independent telephone system" would not have the right to speak over the Post Office trunk wires to any exchange in the United Kingdom on the same terms as subscribers to the National Telephone Company could.

Swansea.—The report of the directors of the Swansea Improvements and Tramways Company states that during the half-year under review negotiations had been actively carried on with the Corporation of Swansea for the purchase by them of the tramways, and for the lease of the undertaking to the company, in anticipation of the time fixed by the Acts of Parliament. This was done to enable the Corporation to relay the lines in a manner suitable for electric traction, and the negotiations included an agreement for the purchase of electrical power from the Corporation by the company, but the negotiations had been brought to a close by the Corporation, and they had withdrawn the Bill in Parliament which they were introducing for the purpose of obtaining the necessary power to carry out the agreement

Bristol.—The Electrical Committee still continue to receive substantial applications for current from private sources. There have been 506 such applications since the light was introduced, and of these 489 have already been complied with to the extent of 28,021 lamps. The total number of lamps applied for by the 506 applicants is 30,509, and the balance is being dealt with at the present moment. The Docks Committee want to light the Bristol Granary by electricity, and Messrs. Marden, Son, and Hall wish to introduce it into their Broad-street factory on an extensive scale. At their last meeting the committee had before them a request for the removal of the electric lamp column at the top of Union street, but as there are certain rearrangements contemplated in Wine street, it was decided not to deal with the request for the present.

Leamington.—At the meeting of the Town Council a letter was read from the Midland Electric Light and Power Company, stating that they believed an erroneous impression prevailed that they should be unable to take up the lighting of the town by means of arc lamps, or that their charges for such lighting would be in excess of those made to other towns. They ventured to inform the Council that they had no difficulty in arranging to supply public lighting of this nature with perfect satisfaction to themselves, and they believed they could, if invited so to do, offer a definite number of lamps and quote the Council a satisfactory price for such lighting. Arc lamps for public lighting had become very popular and had greatly benefited the towns where they had been adopted. The letter was referred to the Watch and Lighting Committee.

Direct Spanish Telegraph Company.—The report of the Direct Spanish Telegraph Company, Limited, for the year ending December 31, states that the accounts show a balance to the credit of revenue of £13 239. After providing for interest on and redemption of debentures, and adding £5,000 to the reserve fund, the balance of revenue amounts to £5,801, and the directors recommend the declaration of a dividend of 10 per cent. on the preference shares, and 4 per cent. free of income tax, on the ordinary shares, which will absorb £5,486; half of this amount was distributed in October as an interim dividend in respect of the June half-year. A balance of £315 will remain to be carried forward. The reserve fund will now amount to £28,498 The traffic receipts show an increase of £4,572, and the ordinary working expenses advanced £238. The cables and the land-lines in connection with them have continued in good working order.

Ealing.—At a meeting of the District Council the clerk read a communication from the Board of Trade, enclosing a copy of new regulations for ensuring the safety of the public, and a proper and efficient supply of electrical energy made by the Board under the powers of the Electric Lighting Acts, and the Ealing electric lighting order. The regulations were referred to the Electric Lighting Committee for consideration The committee reported that they had considered the question of wiring the churches upon the line of the electric mains, of which there appeared to be eight, Episcopalian and others. The committee considered the question of considerable importance, as the introduction of electric light into the churches would utilise the staff and the machinery when not used for other work, and they recommended that representatives of the churches be invited to meet the chairman and the clerk to discuss the matter. This was agreed to.

Lithanode Company.—We have received from the Lithanode Electric Storage Company, 3, Harvey's-buildings, Strand, W.C., a copy of their catalogue of their cells, hand lamps, and medical batteries. The Company in a circular to their customers state that, owing to increased business, it has been found necessary to enlarge their works and provide more adequate accommodation for offices and showrooms. Accordingly the Harvey's buildings premises have been secured, where in future all the business of the Company will be transacted and all communications should be addressed. The new premises include offices, showrooms laboratory, and stores of material required for temporary and decorative electric lighting. Arrangements have also been made for recharging and repairing portable batteries at that address, but returned packing-cases, raw materials, and heavy goods should be sent to the works, at 64, Millbank-street, Westminster, S.W.

Liverpool.—The Health Committee have again considered the request of the National Telephone Company that they may have permission to place the main trunk wires in the central portions of the city underground instead of overhead. A report was presented by the town clerk as to the conditions and terms under which the

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concession might be granted. The chief road surveyor likewise submitted in detail the results of his inspection and enquiries in Manchester, where the system has been adopted. There the wires are carried along a deep trench made in the streets and roads, and certain charges are imposed upon the company for the privilege. The committee authorised the town clerk to submit what is really the draft of a proposed agreement to the Telephone Company. The negotiations are likely to occupy some time and the committee will make no recommendation to the Council until they are thoroughly convinced that a satisfactory arrangement can be entered into with the company.

London School Board.—The School Board for London has determined to make an alteration in the system under which the electric lighting is carried out at the head offices on the Victoria-embankment. Hitherto the eastern portion of the offices has been lighted by current supplied from the mains of the Metropolitan Electric Supply Company, and the remainder (considerably the greater portion) has been lighted by means of the Board's own dynamos. The cost of working the Board's engines, dynamos, etc., for the year ending December, 1895, was £806; and the cost of supplying the eastern portion of the offices from the company's mains during the first five months of the year was only £70 It has been decided to obtain the whole of the supply in future from the mains of the Metropolitan Electric Supply Company. It is estimated that under the new arrangement the six winter months will cost £318 and the six summer months about £70, making a total of £388. Under the old system the cost was over £900.

Newmarket.—At the meeting of the Urban Council the surveyor presented a report on the subject of electric light. He estimates that an installation capable of supplying 4,000 8-c.p. lamps connected can be worked at £600 per annum, after paying interest on capital and sinking fund. He does not think this installation would cost more than £10,000. The cost of production might be taken as under: total works cost, including rates and taxes, 4½ per cent. generating 72,000 units, at 4½ per cent., £1 350; interest on £10,000 loan, at 3 per cent., and repayments to extinguish in 30 years, £510—total, £1,860. Revenue, average units sold per 8 c p connected—say, 18–4,000 by 18 equals 72,000 per annum at 8d. per unit, £24,000, besides meter rents. By having their own electric lighting station they would economise in capital, outlay, and maintenance expenses, and would be able to supply private consumers at a moderate rate. Street-lighting was not dealt with in the report. The cost of lighting the High-street with electricity would be about £200 a year, against £150 for gas, but they would get 10 times as much light. It was decided to apply for a provisional order at once.

City of London.—The Commissioners of Sewers' engineer (Mr. D. J. Ross) has just issued his annual report on the works executed during the year. Referring to the subject of street-lighting, and after mentioning that the number of arc lamps in use in the City is 485, he says: "The important question of lighting the minor streets of the City by electric lamps, under the contract with the electric light company, has again been under consideration. The experiments with incandescent lamps, and with alternating-current arc lamps, in Basinghall-street and Aldermanbury not proving satisfactory, the Streets Committee on June 11 submitted a report from the electrical inspector, and recommended that further experiments with current arc lamps should be made, with the view to determine the description of lamp to be employed. This recommendation was agreed to, and referred back to the Streets Committee to carry out, and arrangements are now being made to light Watling-street, Bow-lane, Bread-street, Friday-street, and Old Change by continuous and alternate current lamps, partly on brackets fixed against the fronts of houses, and partly by lamps suspended across the centres of the streets."

The Hermite Electrical Sanitation Process.—The installation of this system at the military hospital at Netley has now been working since the beginning of the year, and a visit of inspection was made a few days ago by the War Office authorities, who expressed themselves thoroughly satisfied both with the effect on the main sewer and the effluent, and also with the remarkable improvement in the atmosphere of the various wards. The ward-masters are also unanimous in their approval. The French War and Naval Departments have officially approved the system, and are considering to which of their stations it shall be first applied. The Brazilian Government have given instructions for the Marine State Hospital at Rio to be fitted with the Hermite process on the same lines as the Victoria Hospital, Netley. As to the success of the demonstrations of the Hermite process at Rio last year, it may be of interest to state that in that part of the city where the working of the plant has been continued not a single case of yellow fever has occurred, though it is a most insanitary spot, and in previous years has suffered severely. Other parts of the city have suffered as usual from the periodical visitations of this scourge.

Camberwell (London)—The ratepayers have held a public meeting and passed a resolution condemning the action of the vestry in assenting to the proposals of a company to establish itself in the parish, and asking the Vestry to rescind its resolution on the matter. Mr. E. R. Phillips, as chairman of the Electric Lighting Committee of the Vestry, desired to explain the present position of affairs. In January, 1890, the Vestry gave away its right to supply electricity in the parish by allowing a company to secure a provisional order. That company still held that power, but had not taken action. Six or seven months ago another company came forward with a Bill, which had gone up to the Board of Trade, asking practically that they should be allowed to replace the company which at present had power to supply the parish. The Vestry could not oppose it, but they had insisted upon the insertion of a clause in the provisional order giving the Vestry power to buy up the company at the end of two years by paying such an amount of money as should be equal to a sum of £133 for every £100 properly expended on the undertaking. A resolution was also carried urging the Board of Trade to refuse its sanction to the provisional order applied for.

Windsor.—The Windsor and Eton Electric Installation Company having obtained the Corporation's provisional order, a demand for 4,000 lamps will be provided for. Mr. A. H. Preece, A.M I C E, the consulting engineer to the company, has adopted for this undertaking the three-wire low-pressure continuous-current system, which is similar to that used by the Westminster, Pall Mall, Notting Hill, Kensington, Knightsbridge, Charing Cross, and other companies. The generating plant is to comprise two high pressure steam-boilers. The whole of the arrangement of feed water pipes, steam-pipes, pumps, etc., is to be fixed in duplicate. There will be two combined engines and dynamos of sufficient capacity to light about 2,000 lamps; a properly designed switchboard will be erected; a large set of accumulators will also be installed. For the mains, Mr. Preece has adopted a conduit system for the feeders and a solid system for the distributing mains; and he proposes to provide in all the distributing mains and the feeders for a 50 per cent increase in the immediate demand. Mr. Preece's estimate of cost for plant, mains, buildings, etc., is £9,500. It is expected that the work of installation will shortly be commenced under the direction of Mr. A. E. Farrow, resident engineer.

Whitehaven.—The Town Council have decided to oppose the renewal of Dr. Hopkinson's patent in connection with the three-wire system, which patent expires in July next. The Lighting Committee reported that Dr. Hopkinson had tested the cables and found the contract had not been complied with by the contractors; that the insulation was enormously below the standard; that the conductors could not be brought up to it without laying, to a large extent, a fresh cable; and that, where necessary, a five-wire cable should be substituted for the present cable. Dr. Hopkinson also stated that he had a large experience of Messrs. Siemens in carrying out contracts, and his opinion was that, when he drew their attention to the defects, they would remedy them and honourably carry out their contract. It was then resolved that Dr. Hopkinson write Messrs. Siemens explaining the condition in which he found the cables, etc, and request them to remedy the defects, and put the whole into good and efficient working order, in accordance with the contract. Dr. Hopkinson further advised that additional accumulators should be laid down in some convenient position, so as to provide for the increasing consumption, and to meet prospective requirements for some years to come. He recommended the enlargement of the present storage battery, and the provision of a new and more powerful battery, which would be placed near to the point of heaviest load. He estimated the total cost of his recommendations at £1,616. 10s. The report was adopted.

Belfast.—The county surveyor (Mr. John H. Brett) presented a long report at the County Antrim Assizes on the proposed tramway schemes. He said the doubling of the lines as proposed would be very desirable and wholly unobjectionable were it not for the narrowness of one of the roads traversed (Falls road), and the inconvenience that may result. No specific provision was made for giving the county authorities power to intervene against a misuse of the powers which the company may acquire under these clauses. The Bill proposed that the limit of speed should be 12 miles an hour, but this ought to be varied so as to have a much less rapid rate for passing abutting roads or turning corners. It would be advisable to have a limit to the number of carriages or trucks in a train; to the distance between trains in motion; and to the time during which a train may be allowed to remain stationary; also, to require the company to use some very efficient and reliable form of automatic brake on all their carriages and trucks At a meeting of the Improvement Committee a letter was read from the National Telephone Company, Limited, in reference to the adoption of the underground system for their wires in the principal streets, and asking that some of the company's representatives should be received to discuss the matter with the Corporation. The question was held over for further consideration. The electrical engineer has reported on the effect the new regulations promulgated by the Board of Trade would have on the future operations of the department, and has received instructions as to the amending of the wiring by-laws now in force to conform to the new regulations.

Appointments Vacant.—The London School Board require for the training-ship "Shaftesbury," off Grays, Essex, a stoker mechanic having a practical knowledge of electric lighting apparatus and steam boilers; also capable of doing general repairs to pumps, cooking, and other apparatus. Commencing salary £50 a year (which may be increased by £2 10s. a year to £65 a year), with uniform, board, lodging, washing and medical attendance. Applications, in candidates' own handwriting, on forms to be obtained from the School Board Offices, accompanied by copies of not more than three testimonials, must state age and previous experience, be marked outside "Stoker Mechanic," and be received by the Clerk to the Managers, School Board Offices, Victoria-embankment, London, W.C., by 12 noon on 21st inst.—The Corporation of Ashton-under-Lyne invite applications for the appointment of a consulting electrical engineer, to advise the Corporation as to a contemplated scheme for the supply of electric lighting within the borough. Applications, accompanied by a statement of the works carried out by and as to the experience and qualifications of the applicants, must be forwarded by 23rd inst. to Mr. Charles Gartside town clerk, Ashton-under-Lyne.—The Corporation of Bolton invite applications for the appointment

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of electrical engineer. Salary, £300 per annum. Particulars of duties may be obtained from Mr. R. G. Hinnell, town clerk, Town Hall, Bolton, to whom applications, endorsed "Electrical Engineer," stating age and experience, together with not more than four testimonials must be delivered by April 6.—At the meeting of the directors of the Aberdeen Infirmary it was resolved to advertise the vacancy in the combined office of assistant anæsthetist and assistant medical electrician.

Folkestone.—At the meeting of the Town Council the town clerk reported that the Board of Trade had sent down the provisional order, which was simply a copy of the printed one they had previously, with the exception of a few alterations. So far as he was concerned, the form of order was correct, and he asked for a resolution that it he approved and returned to the Board of Trade. Incidental to that matter, he had received a letter from a gentleman, writing from Parliament-street, Westminster, in which the writer said he understood the Corporation were applying for a provisional order, and would be obliged for information thereupon as to whether they proposed to transfer the order to some company. If so, he would be prepared to make a proposal on behalf of himself and the Metropole Hotel Company. The directors intended to light the hotel throughout by electricity, and unless a supply was assured by next autumn they would have to make their own arrangements. The writer was Mr W. B Hopkins. The town clerk read another letter from Mr. Charles C. Wampach, stating that if the Corporation proposed to transfer the provisional order he would pay the sum of £500 for it, and would be pleased to lay before them a scheme for lighting a part or the whole of the town. Councillor Penfold moved, and Councillor Vaughan seconded, that the order be approved, and this was carried. The Town Clerk said he had been asked by a gentleman as to whether any provision could be inserted in the order to permit of electricity being used for the purposes of locomotion. He had written to his agents, and the answer was that it was a question of law, but that they felt the Corporation could only use it for the purposes prescribed in the Act, and they doubted whether that would include electricity for any other purpose than lighting purposes. It was resolved to have a committee meeting of the whole Corporation to discuss matters connected with the electric light question.

PROVISIONAL PATENTS, 1896.

MARCH 9.

5253. Improvements in or connected with the electro-deposition of metals. Sherard Osborn Cowper Coles, 47, Lincoln's-inn-fields, London.

5274. Improved apparatus for the electro-deposition of metals. Alfred Sidney Smith, Thomas Alfred Smith, Roland John Smith, Sidney Smith, and Thomas Deakin, 11, Burlington chambers, New-street, Birmingham.

5295. Improvements in arc lamps. John Albert Seaverns, 24, Southampton buildings, Chancery-lane, London. (Complete specification.)

5298. Improvements in electric flashlight apparatus. Alfred Julius Boult, 323, High Holborn, London. (William Bruns, United States.) (Complete specification.)

MARCH 10.

3515. Improvements in the method of and means for electrically dispatching parcels from one station to another. Edward Henry Seddon 57, Barton-arcade, Manchester.

5320. An improved method of attaching the terminal wires to the zinc rods or cylinders of electric batteries. Isaac Hardy Parsons, 21, Narborough road, Leicester.

5345. Improvements in Gramme ring armatures. Roslyn Holiday and John Freeman, The Arcade, Barnsley.

5408. Improvements in telegraphic relays. Willoughby Statham Smith and William Puddicombe Granville, 24, Southampton-buildings, Chancery lane, London.

5412. Improvements in selecting and operating telephones. Theodore McKenna, 17, Basinghall-street, London. (Herbert Laws Webb, United States.) (Complete specification.)

MARCH 11.

5467. Improvements in appliances connected with electric tramcars and tramways. Edward Hawkesworth Hackett, Penny Bank-chambers, Halifax.

5479. Improvements in alternating-current electric motors for operating commuting devices for converting alternating into continuous currents and other purposes. Anthony Strong Fraser, 73 St Stephen's-road, Upton Park, London.

5480. An improved method of and means for locating leakages on systems of electric conductors. William Valentine Hunt, 73 St. Stephen's-road, Upton Park, London.

5491. Means of varying the speed of asynchronous alternate-current motors. Siemens Bros and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

5497. An electrically-controlled automatic stopcock. Selimo Romeo Bottone, The Limes, Stanley-road, Carshalton, Surrey.

5506. Improvements in electric accumulators. Paul Ferdinand Ribbe, 6, Lord-street, Liverpool. (Complete specification.)

5511. Improvements in arc lamps. William James Davy, 40, Chancery-lane, London.

MARCH 12.

5537. Automatic telegraph apparatus. Georges Hyvert, 8, rue des Princes, Brussels.

5584. Improvements relating to the use and treatment of carbon in electro-chemical or electrolytic processes, and to apparatus therefor. Alfred Coehn, 11, Southampton-buildings, Chancery-lane, London.

5616. Improved electrolytic processes and apparatus. Antoine Edouard Peyrusson, 53, Chancery-lane, London.

MARCH 13.

5673. Improvements in apparatus for refining metals by electrolysis. Alexander Stanley Elmore, 28, Southampton-buildings, Chancery-lane, London. (John Oliver Surtees Elmore, India.)

5703. Improvements in arc lamps. Alfred Julius Boult, 323, High Holborn London. (Wolf Boguslaw Jolles and Eugen Hugo Arthur Heinrich Ritter von Nollendorf, Austria.) (Complete specification.)

MARCH 14.

5752. Electric apparatus for use either as an electromotor or as an electricity meter. John Perry, the Finsbury Technical College, Leonard-street, London.

SPECIFICATIONS PUBLISHED.

1888.

6481. Electrically transmitting power. Lake. (Tesla.) (Second edition.)

1895

3341. Ventilating manholes, electric light boxes, etc. Nisbett.

7315. Electric storage batteries. Barber-Starkey.

7990. Telegraphy. Higgins.

8810. Indicating value of electric resistances Siemens Bros. and Co. (Siemens and Halske.)

14662. Electric signalling apparatus Karn and Payne.

24172. Galvanic batteries. Iwanowski.

1896.

207. Arc lamps Thompson. (Electric Arc Light Company.)

1427. Telephonic apparatus. Marcuse.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	8	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2	1⅜-1½
—— 4½ per cent. Debenture Stock	100	110-113
Charing Cross and Strand	5	7-7½
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7½-7¾
—— 4½ per cent. Debentures	100	116-119 xd
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10-11
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-2¾
Edison and Swan United Ordinary	3	1⅛-1⅜
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅛-1⅜
—— 7 per cent. Cumulative Pref.	2	2½-2¾
Elmore's Copper Depositing	2	⅜-½
Elmore's Wire Company	2	⅜-½
Fowler-Waring Cables (*Reconstructing*)	5	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	16-17
—— 7 per cent. Preference	10	17-18
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	3¼-3½
—— 7 per cent. Preference	5	7½-8¼
India Rubber and Gutta Percha Works	10	19½-20½
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge Ordinary	5	8-8½
—— 6 per cent. Pref.	5	7½-7⅞
Liverpool Electric Supply, Ordinary	5	7½-8
Liverpool Overhead Railway	10	13¾-14½
—— 5 per cent. Pref.	10	16⅜-16¾
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	⅝-¾
Metropolitan Electric Supply	10	13-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	6½-7
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6¾
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	8⅜-9½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	4¾	5½
St. James's and Pall Mall, Ordinary	5	9¾-10½
—— 7 per cent. Pref.	5	9¼-9¾
Telegraph Construction and Maintenance	12	38-41 xd
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	6-6½
Westminster Electric Supply, Ordinary	5	9½-10
Yorkshire House-to-House	5	7-7½

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NOTES.

The South African Cables.—Last Friday the Telegraphs Department gave notice of considerable delay in forwarding messages to South Africa, the East Coast, the Seychelles, Mauritius, and Madagascar.

New Edition.—Messrs. Whittaker and Co. will shortly publish Vol. I. of a new edition of "Electric Lighting and Power Distribution," by Mr. W. Perren Maycock, M.I.E.E. The work will be completed in two volumes.

Liverpool Electric Railway.—At the conclusion of the visit of their Royal Highnesses the Duke and Duchess of York to the Earl and Countess of Derby at Knowsley, it has been arranged that the Duke and Duchess will go to Liverpool and take a journey on the Overhead Electric Railway.

Acetylene.—A petition has been introduced in the Massachusetts Legislature praying that the manufacture and sale of acetylene gas be prohibited on the ground that it is dangerous to life and property. It is also asked that the storing of the chemicals from which it is manufactured be forbidden. A committee of the State Legislature is wanted to investigate and report on the matter.

Carbide of Manganese.—Mr. Henri Moissan has prepared Messrs. Troost and Hautefeuille's manganese carbide in the electric furnace. It is a definite compound corresponding to the formula Mn_3C, and decomposes water with the production of methane and hydrogen. It has been long known that metallic manganese prepared in the ordinary way contains a proportion of carbon, but its properties are different, resembling those of cast iron.

Electric Traction.—According to the *Progresso*, two engineers (Messrs. Martino and Boubée) have worked out a plan for electric traction between Rome and Naples, using the waters of the Volturno as a source of energy, there being, it is stated, a fall capable of giving more than 21,000 h.p. As our excellent contemporary *L'Elettricità* remarks, we must wait for further details before pronouncing whether so large a project can be actually realised.

Spanish Transatlantic Cable.—With reference to the project of a Spanish cable from the Canaries to Cuba, which has been fully described in previous notes, it is now stated that Messrs. Siemens have made propositions to the Spanish Government which the latter have accepted in principle in reference to laying it. The nature of these propositions, of course, is unknown, but the Spanish cable appears a good deal nearer accomplishment than at first seemed probable.

Telegraphs to India.—The Bengal Chamber of Commerce has been urging that there should be cheaper telegraphic communication between England and India. It has been suggested that the example of Australasia and South Africa should be followed. In that case the Governments concerned took half the risk of the loss, the telegraph companies took the risk of the other half, and after a year or two's working the enlarged traffic did away with the loss entirely.

A Sultan's Toy.—The Sultan of Morocco has had built a miniature electric railway, which passes through the different parts of the palace, ending in his bedroom. The equipment includes a car, in which his highness can sit comfortably and smoke while he is making his trip through the palace, which he does several times a day. The cost of this luxury is said to have amounted to £20,000. It should be added that this information does not come direct from Tangiers but from America.

American Institute of Electrical Engineers.—On the occasion of the February meeting of the American Institute of Electrical Engineers held at New York on February 26, before proceeding to the regular business of the evening, a vote was taken on the question of incorporating the institute. The result was unanimously in favour of incorporation. The regular business of the evening was the discussion of Mr. Frank J. Sprague's paper on electric elevators, which was read at the January meeting.

Vienna Exhibition.—In reference to the proposed plan of organising an exhibition in Vienna during the year 1898 in connection with the fiftieth anniversary of the Emperor Francis Joseph's accession to the throne, it is stated that the Lower Austrian Industrial Society has expressed its willingness to finance the enterprise, and that it is proposed to hold the exhibition in the old exhibition building in the Prater and in the spacious grounds which surround it. The exhibition is to remain open from the beginning of May, 1898, until the middle of October in the same year.

Institution of Junior Engineers.—At the conversazione to be given on Saturday at the Westminster Palace Hotel there is to be an exhibition of models and scientific instruments. Mr. A. A. Campbell Swinton will exhibit the new photography, Mr. Robert Paul will show his theatrograph, Mr. Wimshurst has promised experiments with the machine that bears his name, the electrophone will be laid on to the principal theatres, and there will be a musical programme, in which the names occur of Mr. T. E. Gatehouse, Miss Lane, and others, as well as Mr. W. Day's band.

The Telephone Companies.—In the House of Commons last Friday Mr. Henniker Heaton asked the Secretary to the Treasury what percentage of the receipts of telephone companies was payable to the State, and what amount was actually received by the Post Office from the telephone companies during each of the past five financial years. Mr. Hanbury replied that the royalty was 10 per cent. The amount received during the past five financial year was as follows: 1890-91, £44,070; 1891-92, £50,403; 1892-93, £57,620; 1893-94, £65,445; and 1894-94, £72,996.

Japanese Pacific Cable.—According to reports received by way of Canada, the Hawaiian Government have refused the application of Mr. Audley Coote for exclusive landing rights on the Hawaiian Islands for the proposed Americo-Japanese cable. Mr. Coote assured the Hawaiian Government that capital had been secured in Japan with which to construct the line immediately. He asked to be delegated to represent Hawaii in concluding a contract with Japanese principals on the basis of a draft contract submitted. This proposal was also declined by the Hawaiian Government as being beyond their power.

Electric Hæmostat.—At the meeting of the Birmingham and Midland Counties branch of the British Medical Association Mr. Lawson Tait read a paper on the use of a newly-designed electric hæmostat in intra-abdominal surgery. The principle involved is the coagulation under pressure of the albuminous elements of the tissues at a temperature between 180deg. and 190deg. F., the temperature being exactly regulated by means of the known resistance of a given quantity of platinum wire enclosed in a box of non-conducting material, and under the influence of a current accurately controlled by a rheostat or one of Lord Kelvin's balances.

The British Association.—A meeting of the townspeople of Dover has been held in connection with the visit of the British Association to Dover, which is to take

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place in 1899. The reason arrangements were being made so far in advance is that the French Association wishes to make sure of the movements of the British Association before arranging to hold their meeting at Boulogne at about the same time. The French Minister for Foreign Affairs has written to the British Association asking them to hold their meeting at some English coast town, and this has led to the selection of Dover, which has the necessary accommodation for the sectional meetings.

Japan Telegraphs.—According to the Japanese *Electrical Friend*, the survey and preparations for the new cable from Kagoshima, Japan, to Formosa have been completed. The distance is about 900 nautical miles, and the total estimated cost is about £400,000. The cable is to be laid in the course of the summer. The Government is asking for something like £100,000 to improve and increase the telegraph service. For the year ending May, 1894, the total number of messages in Japan was 8,359,139, an increase of 27 per cent. over that of the previous year, while the gross income increased 55 per cent. The Government further propose to change the single-wire telephone system of four towns to a double-wire system, and to open 36 new exchanges.

Telephones and Thunderstorms.—Some time ago enquiries were made by the German Telegraph Department with a view to ascertaining whether the danger from lightning was increased or diminished by the presence of the miles of overhead wires which make up the network of a telephonic system. According to *Das Wetter*, the result of the enquiry has been to show that the presence of the telephone wires tended sensibly to diminish the violence of thunderstorms and to lessen the risk from lightning. A comparison made between 340 towns having a telephone system and 560 not provided with any showed that the ratio of the risk of damage from lightning was as 1 to 4·6 in favour of the former, while the frequency of flashes during a thunderstorm is lowered in the proportion of 3 to 5.

Crossed Wires.—An account is given in *El Telegrafista Español* of an accident which took place in Bilbao on the 16th inst. A wire of the Interurban Telephone Company broke and fell across a cable belonging to an electric tramway, this bringing both on to the telegraph wires. Several of these were melted, and there was a great display of sparks at the telegraph office and a great deal of damage was done to apparatus there. People tried to collect and remove the broken wires and received shocks, but nothing more serious appears to have occurred. Our contemporary, however, states that the occurrence was not altogether unexpected on the part of the telegraph office, and it is contended that the companies should have been compelled to arrange their wires so that such an accident would have been impossible.

Proposed American Pacific Cable.—At a sitting of the United States Senate Committee on Foreign Relations, Mr. J. H. Scrymser has appeared in the interests of the company which proposes to lay a Pacific cable. A bonus of 160,000dol. a year for a period of 20 years is asked for from the United States Government, and in return the company will bind itself to for ever transmit all Government messages free of cost. The rate proposed for private Japanese messages is 1·25dol. (5s. 2½d.) a word, and for Hawaiian messages 35 cents (1s. 6d.) per word, the Press rates to be one-fourth of these. Mr. Scrymser stated that the only obstacle to the early and successful establishment of his cable was the so-called exclusive grant of the Hawaiian Government to Colonel Spaulding, which, he declared, was in the interests of an English cable company.

Rontgen Radiations.—We have already noted that the light emitted by most fluorescing substances contains a proportion of the Röntgen radiations, and that a similar effect has been observed with several substances which give no visible fluorescence. Mr. Henri Becquerel has been investigating the matter, and in a communication made to the Paris Académie des Sciences states that radiations of this character obtained from various uranium salts discharge the electroscope and have all the properties of the new rays. They also appear to be reflected somewhat feebly, though in a perfectly regular manner, from a concave mirror made of tin, and Mr. Becquerel states that he has obtained evidence of "total reflection" and refraction with them in glass. Another communication from Mr. Troost was to the effect that the artificial blende prepared by him in the form of hexagonal crystals when exposed to sunlight gave off the new radiations in sufficient quantity to enable it to be used instead of a Crookes tube in cases where a long exposure was allowable, and that very good negatives had been obtained in this way. It would be a curious result if it should come about in some way like this that the whole of the electrical apparatus now used for producing the Röntgen photographs should be ultimately dispensed with. So far as the experimenters are concerned, the main problem which seems to interest them at present is the attempt to see into people's heads As brain substance is transparent, and bone more or less opaque to the new rays, no very striking result appears possible in this direction.

Lord Kelvin.—In the autumn of the present year Lord Kelvin will complete the fiftieth year of his tenure of the Chair of Natural Philosophy in the University of Glasgow. There are two other instances of an equally long incumbency by a professor at Glasgow. The first occurred in 1761, when Robert Simson, well known for his work on Euclid and other ancient Greek geometers, completed his fiftieth year as professor of mathematics. The second is that of Dr. James Jeffray, who was appointed to the Chair of Anatomy in 1790, and held office for 57 years. The prospective jubilee, both on account of the rarity of such instances and of the eminence of the professor now concerned, naturally calls forth the lively interest and the hearty congratulations of the university and the city of Glasgow, but it has been thought fitting that the occasion should receive a wider recognition, and a joint committee, including representatives of the university and the municipality, are taking measures to secure the participation of universities and scientific and learned societies both in the United Kingdom and abroad, many of which have already testified their appreciation of Lord Kelvin's distinction by conferring upon him honorary degrees or designations, or by enrolling his name among their members. These bodies are now invited to send representatives to a celebration to be held in Glasgow on June 15 and 16 next, on the former of which days a conversazione will be held in the university, and on the latter a banquet in the City Chambers. There is also to be on the same occasion an exhibition of mechanical, electrical, and scientific apparatus illustrating Lord Kelvin's inventive genius.

Telephone Business.—The *Elektrotechnische Zeitschrift*, in its issue of March 19, devotes its "Review" to the progress of the telephone system in various European countries. A good deal of space is given to England in view of the taking over of the trunk lines by the Post Office, and our contemporary incidentally remarks on the extremely high charges made in England as compared with Germany, and recommends the Post Office to reduce these if it desires to attract much business. At any rate it might begin with a cheaper tariff for a night service.

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The urgent necessity of a continuous night and day service is then enforced for all offices with more than 200 or 300 subscribers. From a detailed list of European countries which follows, it appears that there is a continuous service in all the large towns on the Continent with the exception of Rotterdam and Stuttgart. For smaller towns business hours appear to vary considerably, the smaller states giving as a rule the greater facilities. Thus, Switzerland gives a continuous service for all offices with more than 200 subscribers, and Belgium begins as early as five and does not close till eleven. Portugal also appears to give a continuous service. A striking exception, however, is Wurtemburg, where the office hours are from 7 a.m. or 8 a.m. to 6 p.m., though in the capital, Stuttgart, they keep open four hours longer. No information has been obtained as to Hungary, except that there is a continuous service in Budapest, and our contemporary also professes no knowledge of the hours of business in Spain, Russia, Finland, and the Balkan States. Lastly, it is pointed out that the desirability of an all-night service is not merely a question of giving greater facilities for mutual intercourse between subscribers, but involves the increase of their personal security and welfare, since it places them in constant communication with the police, the fire brigade, and the doctor. A constant service at the larger offices is therefore not merely desirable, but imperative.

Tramways.—A quantity of statistics relating to the progress of electric traction in European tramway work are given in *L'Industrie Electrique* of March 10. These are mostly embodied in 10 pages of tables, which are brought up to January 1 last. There are also two additional pages relating to lines either in construction or projected. Owing to the date to which the returns are made up, the latter class does not represent the actual state of things at present in Great Britain, and doubtless it is much the same with several other countries, progress in the direction of the conversion of horse into electric lines having been very rapid. This, however, obviously does not apply to the statistics representing last year's working. During 1895 it appears that the number of electric tramways in Europe increased from 70 to 111, and their total length from 504 miles to 596. The aggregate power of the generating stations has risen from 18,150 kilowatts to 25,095 kilowatts, and the number of motor tramcars from 1,236 to 1,747. So far as track mileage is concerned, Germany heads the list easily with 251 miles of line. Next come France and the United Kingdom close together with 81 miles and 76 miles respectively. Austria stands by herself with about 45 miles, and then come Switzerland, Italy, and Spain in the order named. The rest are of small account, but with the exception of Bulgaria, Denmark, and Greece all the European nations have at least short lengths. Turkey is left out of the list; possibly our contemporary considers that nation only semi-European. It may be said that practically if the English lines are omitted the whole of the European working is on the overhead system. At least, there are only two conduit lines, one in Germany and one in Austria-Hungary. Four lines are worked with accumulators in France, one in Holland, and two in Austria-Hungary. There is also one central-rail line in France, otherwise the trolley reigns supreme. Our contemporary anticipates that before the time comes for publishing next year's list the Heilmann locomotives will be running on the Chemin de fer de l'Ouest, and considers it probable that several lines of tramways will adopt a system of overhead wires up to the town and finish their journey with accumulators, using the same cars and motors. So far as lines in course of construction are concerned, a large amount of work appears to be in progress in Germany and France. With regard to the projected lines, it is hardly worth while reproducing matter which is already out of date.

The Jacques Cell.—Endeavours are constantly being made to devise some method by which the energy obtained from the oxidation of carbon can be converted directly into current without the intermediation of the steam-engine and dynamo. The most recent attempt at the solution of this problem is embodied in an American patent issued to Dr. W. W. Jacques, of Newton, Massachusetts. Dr. Jacques's method is to immerse a cylinder of carbon in molten sodium hydrate and to force a current or blast of air into the molten hydrate in such manner that it becomes impregnated with oxygen in excess over that which sodium hydrate normally contains. A circuit being completed from the sodium hydrate by means of a collecting electrode not chemically acted upon by the molten hydrate and an extraneous conductor to the carbon, an electric current is stated to flow continuously through the collecting electrode and the exterior conductor to the carbon, the strength of the current depending primarily upon the rapidity with which the air is blown into the sodium hydrate. An arrangement for carrying out the process is figured in the New York *Electrical Engineer*. Beginning from the inside, first comes the carbon immersed in the caustic soda solution. A pump forces air into a rose which distributes it evenly into the caustic soda. The solution is contained in a Norway iron pot, which forms the positive terminal, the negative terminal being clamped to the carbon, which is supported in the pot by an insulating cover. The caustic soda solution is admitted and removed by pipes. The whole is surrounded by a furnace which maintains the active cell at a temperature of 400deg. C. to 500deg. C. It is stated that in this process the carbon is gradually converted into carbonic acid, which mostly bubbles up through the hydrate and escapes. The nitrogen with which the oxygen of the air is diluted, having no chemical affinity for any other substance present, simply bubbles through and escapes similarly. Although the greater part of the carbonic acid escapes, it is found that a portion combines with the caustic soda, and this, together with the ash from the carbon, slowly contaminates the caustic soda, and in the course of time lessens its efficiency. The efficiency may be maintained by drawing off from time to time a portion of the contaminated electrolyte and admitting a fresh portion. The contamination may be reduced by adding a small percentage of oxide of magnesium. The current obtainable by this type of generator is said to be very large, but the voltage is low. No definite data as to this or to the efficiency of the cell have up to the present been forthcoming.

Motorcars.—The Honourable T. R. B. Elliot, of Clifton Park, Kelso, has been riding about the border counties of Scotland in a motorcar, no man hindering him. Unfortunately he was imprudent enough to venture into Berwick, whereupon the authorities of that borough promptly asserted themselves and summoned him. The local bench inflicted the moderate fine of 6d. and the immoderate costs of 19s. 7d. The odd penny seems peculiar. A law is a law with the Berwick bench, though there are several forgotten statutes still in force that might startle them to hear of. The new Bill on the subject was introduced into the House of Lords on Monday by Lord Harris. He said the Bill proposed to exempt horseless carriages from the statutory provisions now in force, and, at the same time, impose restrictions with respect to weight and speed. It also reserved certain powers to the Local Government Board and to local authorities. The Bill was read a first time, and there seems little doubt of it passing through. What precise form it will finally take is more uncertain, as

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the traction-engine owners may very probably consider it a suitable occasion for pressing the grievances under which they at present labour. In this connection Mr. James Gray, the secretary of the Electric Construction Company, Limited, has written to the *Times*, calling public attention to the injury our manufacturing industry, as well as the farming industry, is suffering from the legal obstructions to the development of cheap transport by electric traction and horseless vehicles. At present traction on highways by mechanical means is practically prohibited by the Locomotive Acts. If engineers had had free scope for their inventive faculties, traction engines would have been so greatly improved that the same volume of traffic could be carried on highways by mechanical means, but with far less wear and tear than is now done by horses. Railway construction was first developed in this country, and the early experience acquired by our contractors and engineers gave us for many years a monopoly in constructing railways and railway plant all over the world. We are now entering on a new era in locomotion, but our engineers are prevented by legal obstructions from acquiring experience in the new development, and foreign manufacturers who have had facilities for gaining experience are rapidly securing a monopoly of the new business. While Germany and America reckon their electric tramways by thousands of miles, we can only count by tens, and France has hundreds of horseless vehicles against our units. As a natural consequence American engineering companies, by the help of American capital, are providing South Africa with electric tramways; and—will it be believed ?—also England and Ireland. We hear complaints of our want of enterprise in prosecuting foreign business; but in this case at least the blame does not lie with our manufacturers.

Telephones in the Country.—At a meeting of the Fife Farmers' Club last week a paper was read by Mr. Longmuir on the subject of the extension of the telephone service to the rural districts. It was only recently, he remarked, that Government had commenced to show any great interest in telephones. Hitherto it might be said that they had been worked mainly by public companies, but, like the telegraphs, the time could not be far distant when the Government would and must secure the monopoly. Nothing could prevent the nationalisation of the entire system sooner or later, and nothing would hasten that desirable end so much as the cry of the rural districts for it. Referring to the majority report of the Royal Commission, Mr. Longmuir asked his hearers to consider the Government proposal "of promoting the co-operation of occupiers of land with the view of raising the standard of their products, and getting rid of middlemen between the producer and consumer." Now it was quite clear if the farmer was to dispense with the middleman, he must have some means for getting into direct communication with the consumer. As things existed how was he to do so ? On the other hand, were the farmer in telephonic communication with towns and cities he would have an extended field of operation, and would have at his hand at any hour of the day as many buyers and sellers as he chose to establish relations with. The farmer would, by the aid of the telephone, have the entire week in which to make his bargains without the necessity of leaving his farm or waiting replies to letters and telegrams, or confining his trade to one market day or one centre. If they would give the rural housewife a chance of talking by telephone, he thought they might rest satisfied that she would not fail to find markets for her home products at wider ranges than at present. The Minister of Agriculture went abroad to see how light railways were worked, and came back favourably impressed. It was a pity he had not also looked at the working of telephones, and seen how necessary the one was to the other. This country was far behind others as regarded telephones. In Jutland every town and village not only possessed a telephonic exchange, but was connected by trunk lines, and the cost of the service was yearly from £2. 10s. to £3. 10s., the maximum being £4. 3s. 4d. In Norway the system was being successfully and economically worked by municipal and private lines. If Government had money to spare, and intended applying it to relieve the rural districts, let them spend it on some reproductive works, such as telephones. It will be remembered that the whole of this subject was gone into very fully at the last meeting of the British Association, and from Mr. Longmuir's vigorous advocacy, and the way it was received, it may be seen that the idea that there is an extended scope for the telephone in the country is spreading. Of course, it would not be a panacea for agricultural distress, but since what is done in Denmark and Sweden could be done in England, there is no reason for confining every improvement to the towns and leaving out the country altogether.

Electrical v. Steam Railways.—In view of the fact that several important schemes for electric railways are now before the public in one form or another, the *Financial Times* has been discussing from a financial point of view the question of the comparative merits of electricity and steam as a means of locomotion. The City and South London Railway has been in operation for over five years, and though its financial results have not up to the present been very satisfactory, that is due to its being practically the pioneer of this form of locomotion, and the experience it has had to pay for will prove of great value to its successors in this form of enterprise. Besides, it has shown steady improvement in its dividends, these having risen from nil in 1891 to $1\frac{3}{16}$ in 1895. The Liverpool Overhead Railway, though only opened in March, 1893, managed to pay a dividend of $2\frac{7}{8}$ per cent. for the year 1895 on its ordinary capital. This company is, however, in a specially favourable position on account of its low cost of construction. The higher cost of working by electricity has up to the present been a stumbling-block to its more extended use, but this is being gradually reduced. The amount of this higher relative cost of electricity as compared with steam may be seen from a comparison of the percentage ratio of working expenses to gross receipts in 1895 of the electric and the metropolitan lines. This stands as follows: Liverpool Overhead Railway, 63·0; City and South London, 60·6; Metropolitan, 43·2; Metropolitan District, 46·9. Where electricity as a hauling power is principally at a disadvantage seems to be its small earning power per train mile. The electric trains so far produced are small, and have not nearly so large a carrying capacity as the trains now running on the Metropolitan and District Railways. Therefore, it is necessary for the electric trains to run a much larger number of miles than would be necessary for the trains hauled by steam power to earn the same amount. From this it follows that, though the working cost per train mile on the electric railways is less than half the rate of the other two companies, the gross earnings are also very much lower. The average number of passengers carried per train mile, exclusive of season-ticket holders, in the case of each company was as follows: Liverpool Overhead, 11; City and South London, 14; Metropolitan, 44; Metropolitan District, 26. As regards initial cost, the City and South London has great advantages over the old underground companies, and the same feature applies to the new schemes for electric railways which have taken shape during the last few years. Per mile of its line, the City and South London cost on the

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average less than £300,000, including equipment, compared with about half a million per mile in the case of the District Company. All this is doubtless true enough, but it is a little unfair of our contemporary to compare two lines built with the intention of supplying a service that should be something intermediate between a railway and a tramway service with two of the heaviest class of railways. Some people consider that the Metropolitan District has not been a brilliant financial success.

Civil Engineers.—The question of the standard with which the results of steam-engine trials should be compared has occupied considerable attention in several papers on steam-engine economy which had, during the past 14 years, been read and discussed at the Institution of Civil Engineers, and the subject was again taken up in a paper on "The Thermal Efficiency of Steam-Engines," read last Tuesday by Captain H. Riall Sankey, R.E. (retired), M.I.C.E. The view adopted was that in order to obtain full information of the thermal performance of an engine, two efficiencies had to be stated—namely, the absolute thermal efficiency and the "standard" thermal efficiency, the latter denoting the comparison of the actual engine with an ideal steam-engine working within the same temperature limits. In other words, the "standard" thermal efficiency was the absolute thermal efficiency of the actual engine divided by the absolute thermal efficiency of the ideal steam-engine chosen as the standard. It was the choice of this standard which had caused so much discussion. The true object of such a standard was to provide ready indication as to how far the particular engine under consideration fell short of what was physically possible within the limits of temperature by which the engine was bound, having regard also to the varying temperature at which the heat was supplied to the feed water, and it was shown that this requirement was met by the Clausius "perfect" steam-engine, slightly modified, however, as regards the point to which the expansion was carried. To assist in a decision as to the standard to be adopted, other ideal engines which had been proposed or used as standards were considered; for instance, the Carnot cycle, the engine whose expansion line was the saturated steam-line, and the engine the expansion line of which followed the law $p\ v =$ constant; and in each case it was pointed in what respects the requirements of the standard were not fulfilled. This comparison was also made by means of the $\theta\ \phi$ chart. The object of limiting the expansion, as suggested above by carrying it down to within 0·15 atmosphere of the actual back pressure, was to obtain a compromise between the two following conditions: if the expansion were carried to the back pressure, the standard would lead to the use of engines too large for their work; if, however, the expansion in the standard were only carried to a pressure equal to the back pressure plus the mean pressure (referred to the low pressure) corresponding with the friction of the actual engine, a premium was, so to speak, awarded to a stiff engine, and the standard would be made to vary with the stiffness of the actual engine. In many cases a comparison of the actual engine with what the author proposed to call the "type" standard was useful. The type standard was an ideal engine which took into account the clearance, compression, back pressure, etc., necessary with the particular type of engine under consideration. For instance, the ideal engine with an expansion line following the saturation line was the type standard for a jacketed engine. The difference in the amount of heat utilised by the standard and the type standard showed the unavoidable loss normal to the particular type of engine, whereas the difference in the heat utilised by the type standard and the actual engine gave the more or less avoidable loss.

Electric Tramways.—In the course of a lecture delivered at University College, Nottingham, on the subject of electric tramways, Mr. G. E. Coke, A.M.I.C.E., remarked that though the results of experiments with electric tramways in the United States had been so successful that continual additions were being made, in this country very little progress had been attained. The installations which were now in operation in the United Kingdom were small, and must be regarded as largely tentative and experimental. Mr. Coke thought that for many reasons the American appellation "street railway" was greatly preferable to the indefinite English term, "tramway." It was due to the energy and far-sighted policy of the Americans that their street railways were now the best in the world. Referring to American practice, it was remarked that it was not unusual for a street railway to lease its supply of power, either from another railway or from lighting and power distribution companies, on the basis of a given rate per car mile. Three-halfpence per car mile was about the rate charged for this service, and a company running 18 hours per day and making 125 miles per car per day would pay the supply company from 8s. to 16s. per car per day. In Chicago, New York, and San Francisco the cable system was at its best. In smaller towns, where the traffic was not so great, where curves and branches were of constant occurrence, where suburban routes were in question, or where the cost of roadbed and power plant must be kept within reasonable bounds, the electric system found a field that the cable system could never satisfactorily fill. In the great centres of population cable and electricity worked harmoniously together as component parts of the same system, each fulfilling that portion of the service to which it was best adapted. The enormous carrying power of an electric road when called upon to meet the demands of heavy service was an important feature of the system. With regard to Europe, the narrow streets of Continental towns had proved no barrier to electric roads. A noticeable instance of this was the Essen line, where the electric line traversed streets only 13ft. wide between house fronts. Some conversation followed principally in reference to the local circumstances of Nottingham. In answer to a question on the subject of gradients, Mr. R. J. Wharton, who represented the British Thomson-Houston Company, said that, so far as electrical tramways were concerned, he did not think they had yet reached the limit of gradients. The lecturer had shown a view of a gradient in San Francisco which was 1 in 7½, but he believed some eminent engineers maintained that that was not the limit. He believed that there were few places in England where they would meet such a steep gradient as 1 in 7½. As to the question of speed, they could run at any speed desired, but the Board of Trade and the local authorities did not like a high speed. With regard to the cost he might quote the instance of Bristol, where about four miles of double trams had been equipped for just about £50,000 on the overhead system. If, however, they went to the conduit, the system would cost much more. Sir John Turney, who presided, in moving a vote of thanks to the lecturer, said that he had seen no gradient or curve that a driver would hesitate or stop at. In Brooklyn drivers seemed to take no notice of curves, gradients, or roads, and some of the latter were like ploughed fields. He thought that they in England knew quite sufficient about electricity, and it was a pity that they had been so slow in applying it. The time had come when something should be done in Nottingham and other English towns.

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CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXVI.

(Specially Contributed.)

Resistance Coils.—We have seen that the unit of resistance called the *ohm* is that of 106·3 centimetres of mercury whose sectional area is constant and whose mass is 14·4521 grammes at 0deg. C. or 32deg. F. For practical purposes mercury standards are useless; so secondary standards are constructed of German silver, or platinum-silver, or other suitable conductor are made. These are called resistance coils, and can be obtained in any desired multiples or sub-multiples of the ohm. A good deal of skill has been brought to bear upon the making of resistances, but there are certain broad lines which all makers follow. Fig. 1 shows

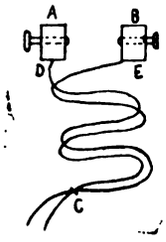

FIG. 1.

one resistance coil. Its resistance has to be carefully measured against standard resistances; it must be constructed of material that does not change its resistance much with change of temperature; it must be insulated against accidental contact with other conductors, guarded against moisture, and doubled back upon itself in winding, so that the field of one half neutralises the field of the other half, otherwise the field of the resistance might affect the instrument used in measuring. The workman takes two equal lengths of the wire—say German silver—to be used (by practice he knows about the right length), places the ends, say, D E, quite level, and solders together the other ends at C. He then has a resistance, D C E, which is accurately measured. If too great a resistance is found, the circuit is shortened by soldering up a little at the end, C, till exactitude is obtained. The wire is, of course, insulated. The free ends, D E, are connected to big conductors, A B, which form binding screws or contact-pieces, and have no appreciable resistance. The double wire is usually wound round a cylinder of wood, paraffin paper, ebonite, or other suitable material, and put into a containing box, which again is often filled with paraffin. A modification of this plan is shown (Fig. 2)—

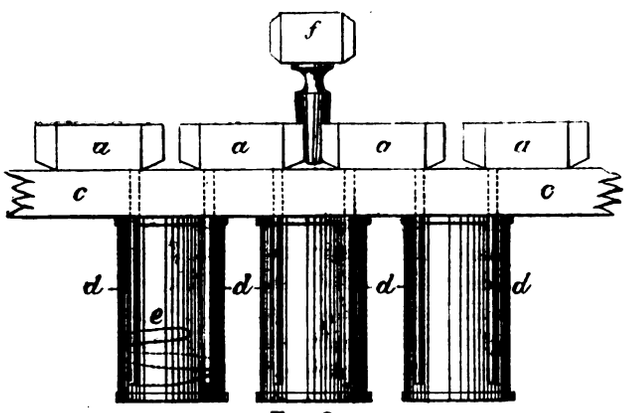

FIG. 2.

a a a a are thick blocks of brass or suitable conducting metal; *f* is a plug, the lower part of metal conical in shape to fit the conical holes bored in the blocks, *a a a a*, the upper part, *f*, is of ebonite or some non-conducting material; *c c* is an insulating cover. Below the cover are shown three boxes of ebonite or other insulating material. Each box contains two thick conducting rods, *d d d d*, going through holes in the cover, *c*, one rod being connected to one end of a block, *a*, the other rod similarly connected to the end of the next block, *a*. The end of the rods in any one box are connected by a wire, *e*, whose resistance has been carefully measured by comparison with standards. This wire is doubled on itself to prevent self-induction. The thick rods, *d d d d*, and the blocks, *a a a a*, should be massive enough to have no observable resistance. If, now, the boxes contain resistance respectively of 1, 2, 3 ohms, and so on, we can substitute these known for unknown resistances. In many cases the insulating boxes are not used, but a number of resistances are put into one box and separated by pouring in paraffin. When the plug, *f*, is out from two adjacent blocks the two resistances are in series, and by having a sufficient number of graduated resistances, they can be arranged so as to give any total resistance up to the limits of the apparatus. Fig. 3 shows another modification

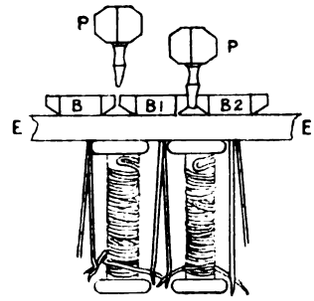

FIG. 3.

in the way of making the series of coils. B, B_1, B_2 are blocks of brass upon the ebonite slab, E E. One end of first coil is connected to B, and the other end to the one end of the next coil and block B_1, and so on. P P are contact plugs with ebonite tops, as before.

Resistance Boxes.—The large number of ways in which resistances are grouped in boxes makes it impossible to do more than illustrate one or two of them, but in

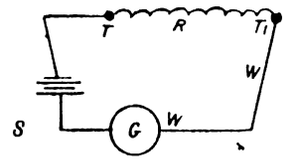

FIG. 4.

order to understand how resistance boxes may be used I will point out one or two cases of interest. Suppose, then, I have to find the value of an unknown resistance, the two ends of which can be connected to the two terminals for that purpose in a circuit, as Fig. 4. Here S may, as usual, indicate our source of electricity which of course, will be selected for the purpose in hand, the lines in the diagram signifying simply source. T and T_1 are two binding screws, between which the unknown resistance, R, may be connected. The circuit is completed through a galvano meter, as shown, and when it is completed the galvanometer will show a certain deflection. Note that deflection.

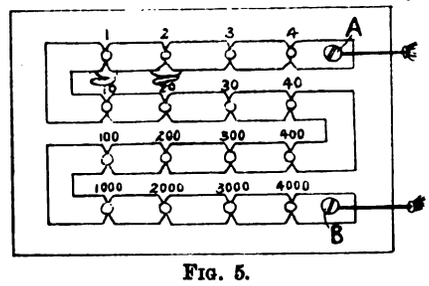

FIG. 5.

Now, if instead of the unknown resistance, R, I connect a box of known resistances between T and T_1, and unplug resistances till the deflection on the galvanometer is the same as it was with R in the circuit, then the sum of the resistances unplugged in the box will equal the resistance of R. In this case I merely substitute known resistances for the unknown, and when the deflection in the one case is the same as the deflection in the other, then I know the substituted resistance is the exact equivalent of the till then unknown. This method of

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determining resistances is called the substitution method. It has the disadvantage that it is not always possible to get an exact substitution. We may not have sufficient known resistances to be equal to the unknown, or our known resistances may not be small enough or divided into sufficiently small sub-multiples to get an exact balance. Then, of course, we have to employ other methods. However, a box of resistances for the substitution method may be arranged as in Fig. 5, which will permit of the use of resistances in complete ohms from one ohm to 11,110 ohms. All the combinations can be made by means of one box containing 16 coils, each of the resistance shown by the number annexed to it. Connection with the circuit is made by means of the screws, A and B. Another arrangement is shown in Fig. 6. Here one contact is made through

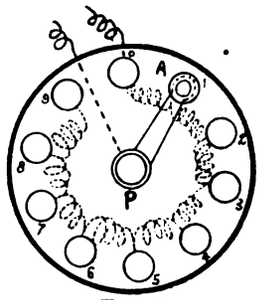

Fig. 6.

the central pivot, P, and another through the terminal, O. The resistances in the circuit vary according to the position of A. As shown, the resistance 01 only is in circuit. If A was moved on to contact 5 then all the resistances between 0 and 5 would be brought into the circuit.

Gilbert or Wheatstone's Bridge.—I have indicated that the substitution method can only be used under certain conditions. If these conditions do not hold other methods must be followed, and one of very general service for which many forms of resistance boxes are made is the Wheatstone bridge method. Suppose Fig. 7 to represent a complete circuit with source, S, and branch conductors, A C B, A D B between A and B. Let A C B = A D B in all respects. If, then, I take a point, C, in A C B, and a point, D, in A D B, so that A C = A D, and join C D through a galvanometer, G, there ought to be no deflection on the galvanometer, because the pressure at C should = pressure at D. No matter the pressure at A, if A C = A D in all respects, the fall of pressure along A C should be exactly similar to the fall of pressure along A D. Whatever current goes through A C, then, will go through C B, and, similarly, whatever current goes through A D will go through D B, and no current will go from C to D, because the pressure at the two points is equal. That is the simplest case. Further, only suppose that the resistance A C B

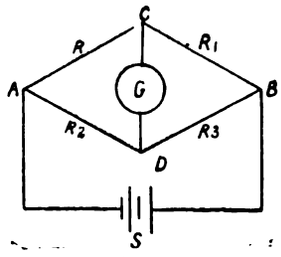

Fig. 7.

= resistance A D B, and that C and D are two points respectively in A C B and A D B, such that when joined through a galvanometer no current flows through the galvanometer; then C and D must have the same pressure, and C must divide the whole resistance A C B in the same proportion as D divides the whole resistance A D B. Calling the resistance A C = R, C B = R_1, A D = R_2, and D B = R_3, we may write

$$R : R_1 :: R_2 : R_3,$$

which reads: the resistance R bears the same ratio or relation to the resistance R_1 as the resistance R_2 bears to R_3.

A little knowledge of arithmetic and algebra tells you that $R : R_1 :: R_2 : R_3$

may be written $$\frac{R}{R_1} = \frac{R_2}{R_3},$$

whence $$R_3 = \frac{R_1 R_2}{R}.$$

If now R_3 is an unknown resistance, it can be determined if we know R_1, R_2, and R.

Fig. 8 shows a form of resistance box so arranged that the unknown resistance forms one arm of the bridge, such

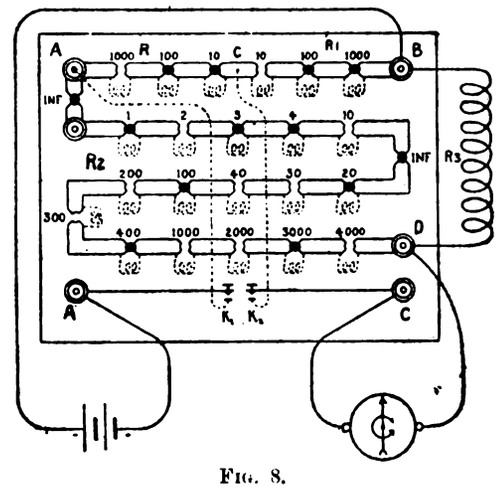

Fig. 8.

as R_3 in Fig. 7, and the other three arms are formed by the arrangement. I can make this clearer by means of the diagram taken from Niblett and Ewen's "Instruments." The source is connected through K_1 to the point A and to B. The resistance R is A C and R_1 is C B. The three rows of resistancess 1 to 4,000 represent A D, and the unknown resistance between D B represents R_3 in Diagram 7. The galvanometer, G, is connected through K_2 between D C. This arrangement is known as the Post Office pattern.

Suppose, now, in A C (R) we employ 1,000.
" " C B (R_1) " 10.
" " A D (R_2) " 2 + 10 + 30 + 40 + 200 + 300 + 1,000 + 2,000 + 4,000 = 7,582,

then, as $R_3 = \frac{R_1 R_2}{R}$

$$= \frac{10 \times 7,582}{1,000} = 75{\cdot}82.$$

Hence you will see that by this bridge arrangement we can easily measure the parts of an ohm although all our coils are multiples of an ohm.

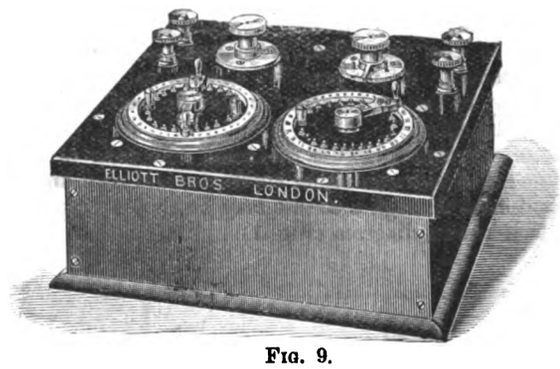

Fig. 9.

Suppose we reversed the ratios $R : R_1$ from 1,000 : 10 to 10 : 1,000—that is, unplugged 1,000 in C B and 10 in A C—then the above would have become

$$\frac{1,000 \times 7,582}{10} = 758,200.$$

Thus, by selecting suitable ratios in the arms, A C, C B, we measure accurately to parts of an ohm, or far beyond the total of the resistances of the instrument.

Although there are many forms of resistance box, they

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are mostly made with a view to be used in the substitution for unknown resistances, or to form the known resistances in the arms of a Wheatstone's bridge. Fig. 9 shows a convenient form, as made by Messrs. Elliott Bros., with circular contacts.

EARTHING THE MIDDLE WIRE.

BY J. PIGG.

The probable more extended use of 200 to 250 volt incandescent lamps consequent on the success of the radical changes initiated by Mr. Baynes at Bradford, the raising by the Board of Trade of the low-pressure limit from 300 to 500 volts, and the consequent increase of pressure at consumers' terminals on three-wire systems, renders the question of earthing the middle wire peculiarly interesting at the present moment.

There are already indications that the subject is receiving some attention, and there has appeared in the technical Press an opinion from the electrical adviser of one of the chief insurance offices on the possibility of the full difference of potential being brought by a certain combination into one set of premises, although these premises are wired between the middle and an outer.

The hypothetical case cited, whilst not very likely to occur under ordinary circumstances, is possible, but it is by no means peculiar to a three-wire system, with either earthed or insulated middle wire. Every electrical engineer who has given attention to the requirements for effectually testing his circuits, is aware that he must take into account the possibility of both mains coming into more or less intimate contact with a comparatively well-insulated conductor at different points on the system, and that he must arrange his tests to detect such a fault.

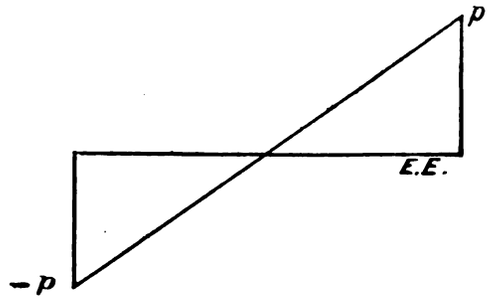

FIG. 1.

These faults, of course, are rare, but they may nevertheless be a source of danger. The combination put forward in the letter referred to is simply a variant of this class of fault, and the variation consists in the resistance between the two faulty points.

Whilst it would be foolish to assert that there is no danger to the individual from such a combination of circumstances, it is equally unwise to exaggerate the possibility of its occurrence or the impossibility of minimising the effect.

In any electrical circuit the total difference of potential is twice that between either conductor and zero, and the fall of potential through a circuit may be shown graphically by the well-known diagram (Fig. 1).

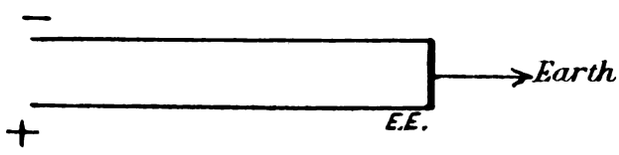

FIG. 2.

If the potential at one end of the conductor is P, the potential of the other end will be −P, and there will be a point at the centre of resistance, in a simple circuit, at zero potential. If the point at zero potential be put to earth, no disturbance of the electrical conditions of the circuit will result as long as the insulation of all other parts of the circuit is maintained.

If we consider such as circuit as Fig. 2 under the assumption that the resistance of all parts of the circuit to earth is infinite, with the exception of the zero point which is connected directly to earth, we see that there can be no leakage current either to earth or between the conductors.

Suppose that a leak develops on one of the conductors, as shown at *a* on Fig. 3.

If *a* is at a higher potential than the earth, some current, depending upon the resistance between *a* and A and the difference of potential, will pass between these points, and it by no means follows that the path of the leakage current will be "as the crow flies." A well-known proposition states that potential energy always tends to a minimum, and for this reason the path, or paths, selected are always such as tend to make the leakage current a maximum.

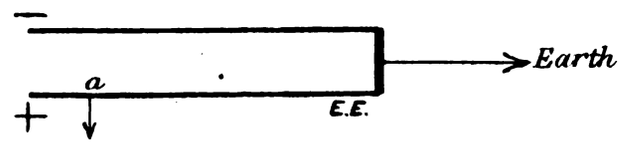

FIG. 3.

Hence such currents spread themselves over a considerable area, more especially when the distance between the points is considerable, and the resistance comparatively great.

Suppose, now, that in addition to the leak *a*, a leak, *b*, has developed on the other conductor, as in Fig. 4. The leakage currents are now less simple. There will still be leakage from *a* to A, and, in addition, there will be leakage from *a* to *b*. The latter leakage current tends to be greater than that between *a* and A, in consequence of the greater difference of potential existing between *a* and *b*, and the paths of the current between *a* and *b* are equally as devious, or more, as that from *a* to A.

The effects which may be produced by these stray currents are of great importance, and constitute the principal reason for any consideration of the matter of leakage. If the only reason for consideration was the loss accruing from leakage, the matter would not need to occupy much attention. Experience accumulated in practical working,

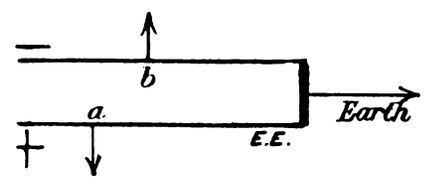

FIG. 4.

however, has shown that the loss due to leakage is an extremely small matter compared with the damage that may be done by the currents in their course from one leak to another.

The effects of the current are chemical, thermal, and magnetic, and to these must be added the effect upon the individual. If water is present at a leaky point on a conductor we may have an evolution of an explosive mixture of gases, or the metal of the conductor may be decomposed, or we may have both these chemical actions simultaneously, and the quantity of gas liberated and the decomposition of the conductor will be proportional to the strength of the leakage current. Electrolytic action may also take place at the surfaces of metals entirely unconnected with the circuit, but which are traversed by the stray currents in their course between two leaks.

If the leakage currents are comparatively large, their passage may, under favourable conditions, result in the outbreak of a fire at some point, and the danger is, in this case, proportional to the square of the leakage current.

If other electrical apparatus, using earth, exist in the neighbourhood of the stray currents, the latter may find their course facilitated by taking the line wire, or wires, as part of their path, and where delicate instruments are in use may cause considerable trouble and inconvenience.

The effects on the individual, although placed last, are by no means of the least importance. Whilst the current or difference of potential "that kills" may still be a matter of debate, and may largely depend on physical conditions, yet it is undeniable that the effects which may be produced

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by even such a difference of potential as is now allowed as the limit of low pressure are unpleasant in the extreme, and may, to the debilitated, be serious.

Consider such a case as that shown by Fig. 2, with the earth connection at A removed. Any person standing on the ground and touching one conductor will experience, at most, the effect due to being charged to the same potential as the part of the conductor touched. If the earth connection at A was in existence when the wire was touched, a current would pass, the magnitude of which would depend upon the total resistance and the position, relatively to A, at which the wire was touched. Hence, for wires having infinite resistance to earth, the effect upon the individual is likely to be greater when an earth connection exists at A than without.

Consider next the effect on an individual who may touch either conductor with such a combination as Fig. 3. If he touches the leaky wire the effect on him will be less than it would if the leak *a* did not exist, and this lessening of effect is due to the existence of the earth connection at A. If, however, he touches the – wire the effect on him will be greater than if the leak *a* did not exist, and this effect will be the greater the more nearly to *a* he touches the – wire, and the less the actual resistance of the leak *a* to earth. Further consideration, however, shows that the effect will be less with the earth connection at A than without it, since some current must be passing from *a* to A.

Again, consider the effect produced under such circumstances as are shown in Fig. 4. Any person forming a connection between the + and – wires will have applied to his extremities a difference of potential which will be in some way proportional to the difference of potential existing between the wires, but which, as was found in the case of Fig. 3, is minimised by the existence of the earth connection at A. The actual difference of potential applied to his extremities will also depend greatly on the resistances of the leaks, *a* and *b*. If the resistance of the path, of which he forms a part, extraneous to himself is great compared with his individual resistance, the difference of potential at

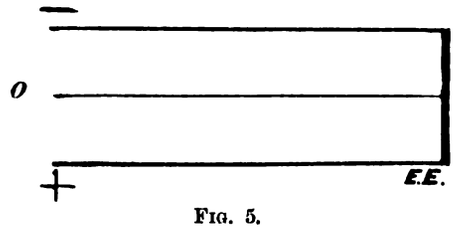

Fig. 5.

his extremities will be small compared with the total, and *vice versâ*. In any case, it is of importance to notice that the presence of the earth connection at A tends to minimise the effect produced.

A further careful consideration of Fig. 2 will show that the maximum stress across the insulating material is only that due to half the difference of potential existing between the wires, and the effect is the same whether the earth connection at A is existing or not. Consideration of Fig. 3 will show that the existence of the leak *a* will increase the stress across the insulating material of the – wire, but it also shows that the increase is less than it would have been had the earth connection at A been absent. Consideration of Fig. 3 also shows that the + wire carries less current than the – between the points *a* and A, and that the path of the leakage currents will concentrate in the earth connection at the latter point, and the whole current will pass through that portion of the apparatus connected between A and the – wire. Further consideration of Fig. 4 shows that a greater current exists in the + and – wires before reaching *a* and *b* than after, and that an inequality of currents will exist between the + and – wires between *a* and A and A and *b* respectively. Obviously, any safety device to prevent excessive leakage for such a defect as shown in Fig. 3 may be placed between A and the – wire, but a safety device for such a defect as in Fig. 4 must be placed somewhere near the source of generation. If the fault *a* (Fig. 3) existed alone, and the earth connection at A was not in existence, no leakage would take place. With the earth connection at A leakage does take place, and if the magnitude of the fault *a* is great, and the leakage current sufficient to actuate the safety device between A and the – wire, it will, by this action, notify its existence, which might otherwise remain unsuspected. If the fault *b* existed alone, the leakage currents from A to *b* would actuate safety devices placed between A and the + wire in exactly the same way.

Consider such a circuit as Fig. 5, and assume that all three wires have infinite resistance to earth. In this case we have Fig. 2 without the earth connection at A, and the effects are similar to those deduced in all respects. If faults develop on the + and O cables, leakage will occur. If faults occur on all three cables, the leakage currents will be similar to Fig. 3. In this case, however, we see that safety devices, to effectually protect against the effects of defects between apparatus and the middle wire, must be inserted at the point of junction with the middle wire.

Consider Fig. 6, and, assuming that none of the wires are purposely earthed at any point, but that leaks exist at *a*, *b*, *c*, and *d*, there will be leakage between *a* and *b*, *a* and *d*, *c* and *d*, and *c* and *b*. Each of these currents will split, and describe a number of stream lines, and the area affected by them in a large network may be much greater than the area covered by the network itself. The necessity for double-pole fuses, or similar devices, is also very apparent if faults exist on all three wires, as shown in the figure.

Now, suppose the middle wire to be purposely earthed at *e*. Leakage will now take place as before, but the area covered by the stray currents is restricted by the presence of the earth connection. If an additional fault developed at *f*, there would be some leakage from *f* to *d* and *b*. The leakage current between *f* and *b* would affect the fuse on the middle wire only, and it is therefore still necessary that double-pole fuses should be used to protect the branch.

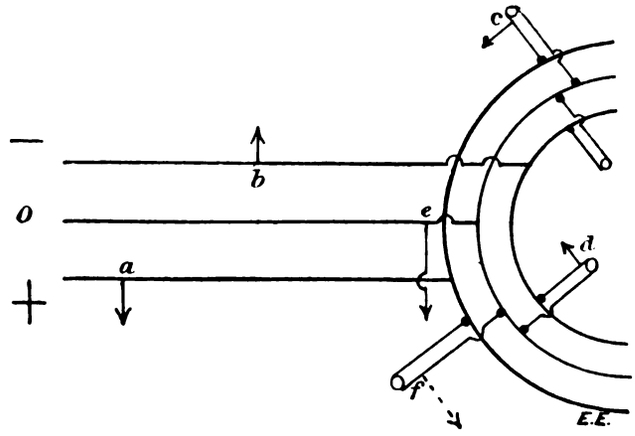

Fig. 6.

If the middle distributor is earthed throughout its length, the area covered by stray currents due to defects in the distributors is very greatly reduced, but the stray currents due to defects in the feeders are comparatively unaffected. One result, however, of earthing the middle distributor throughout its length is that single-pole fuses, placed between the apparatus and the outer, are required only. Fuses between the apparatus and the middle wire are superfluous, since leaking currents passing through defects between the apparatus and the middle wire must pass through the fuse on the outer.

Suppose, however, that O is entirely uninsulated throughout its whole length, and the outer + and – wires have infinite resistance to earth. The case is again analogous with Fig. 2. The extreme difference of potential applicable to an individual in connection with the earth, and touching one wire, is only half the total difference of potential existing between the + and – wires. The stress upon the insulating material is also that due to only half the total difference of potential, and if the current in the + and – wires is the same throughout their length there will be no leakage currents. If the balancing is not perfect, and current passes through O, there will be leakage currents, but their magnitude and range will be limited by the maximum difference of potential between the ends of O, and not by the maximum difference of potential between

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the outers. This difference of potential may be reduced to any extent, for any given degree of unbalancing, by increasing the section of O.

If Fig. 6 is considered under the assumption that the wire O is perfectly earthed throughout its whole length, it will be found that the area occupied by leakage currents is greatly circumscribed. Leakage currents will more readily pass from *a* to O than to *b*, *d*, or *f*, and if the + and – wires experience no other resistance to O than that of their respective insulating material, the area covered by leakage currents will be still further restricted, the disturbance of other electrical circuits and the thermal and electrolytic continued throughout the system, the chance of such a combination as that referred to in Mr. Snell's letter would be very remote indeed.

As to how far electrolytic action on the uninsulated middle wire would affect the working in the course of time it is scarcely possible to say. Cases have been cited which tend to show that the danger is more imaginary than real. In any case it would seem necessary to specify the maximum allowable difference of potential between the ends of the middle wire. Moreover, it would seem possible to partially shield the conductor from electrolytic action by earthing through earth rods or plates. Electrolysis would then

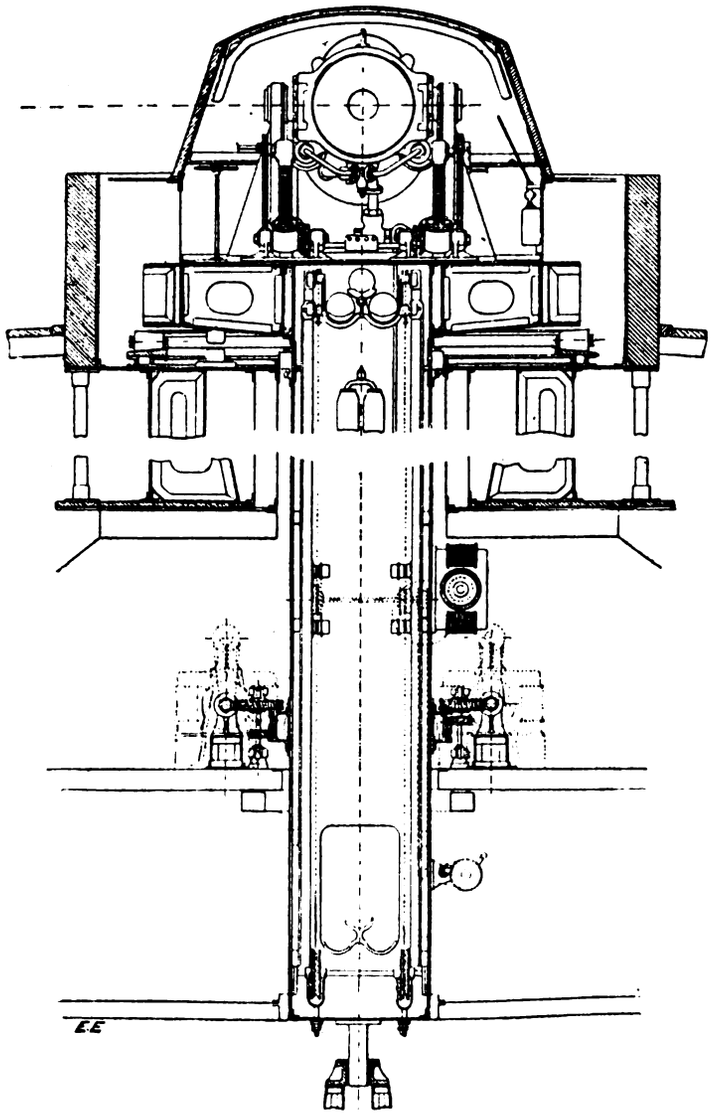

FIG. 1.—Section of a Turret on the Cruiser "Capitan Prat" showing Electric Motors.

effects will be diminished, the danger to the individual will be less than if the middle wire was insulated, and the number of fuses required will be diminished by half.

The whole question would seem, from the considerations adduced, to turn on the maintenance of the insulation of outer + and – wires. If this insulation can be maintained, no advantage results from the earthing of the middle wire. If the insulation cannot be maintained, and it seems difficult to conceive it possible under all circumstances, there would seem very substantial advantages to be gained by earthing the middle wire.

The most suitable method would seem to be to use two concentric mains, the outers of which are uninsulated, and which would, jointly, constitute the middle wire. The outer uninsulated conductors of both concentric mains would be connected together, electrically, at short intervals; so that the whole section of the middle wire would be available for currents passing through it. Under these conditions any defect would show itself at the fuses at once, and there would be practically no stray currents except those due to difference of potential between the ends of the middle wire; and if this class of wiring was occur principally at the earth-plate, and the middle wire would be thereby protected.

ELECTRIC TURRETS ON THE CRUISER "CAPITAN PRAT."

The following description of the turret on this warship is abstracted from an article in *L'Electricien* by G. Dary. The question of applying electric energy for the manœuvring of large guns has been under consideration since 1885. About that time the English Admiralty and the similar department in the United States of America ordered experiments to be made to find the most simple and effective means of adapting electromotors for the training of guns and for the ammunition hoists. Messrs. Symon and Maxim were early in the field, and invented a cannon which could be easily operated by one man. This was worked by one motor only, and was also fired electrically. The Chilian Government, when ordering a new cruiser, invited several European designers to submit

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plans to an international commission. After careful examination this commission gave this important work to the Société des forges et chantiers de la Mediterranée. The plans were those of Mr. Lagane, who is chief engineer to the above company.

The cruiser "Capitan Prat," which was launched in 1893, is 328ft. long by 60ft. 9in. beam, with a draught of 21ft. 8in. Its tonnage is 6,800. Its artillery consists of four 9½in. guns placed in barbettes fore and aft, and one on each side of the lighting purposes, and the switchboards are so arranged that the machines can be used on either circuit. Duplicate circuits are also run to each turret and gun.

On the shaft of each motor is placed a worm gearing into a worm-wheel with a vertical axis. This shaft carries a pinion gearing into a spur wheel concentric with the central tube of the turret, and which drives it through a spring attachment. This prevents sudden shocks. The switch gear is placed under the charge of the chief gunner,

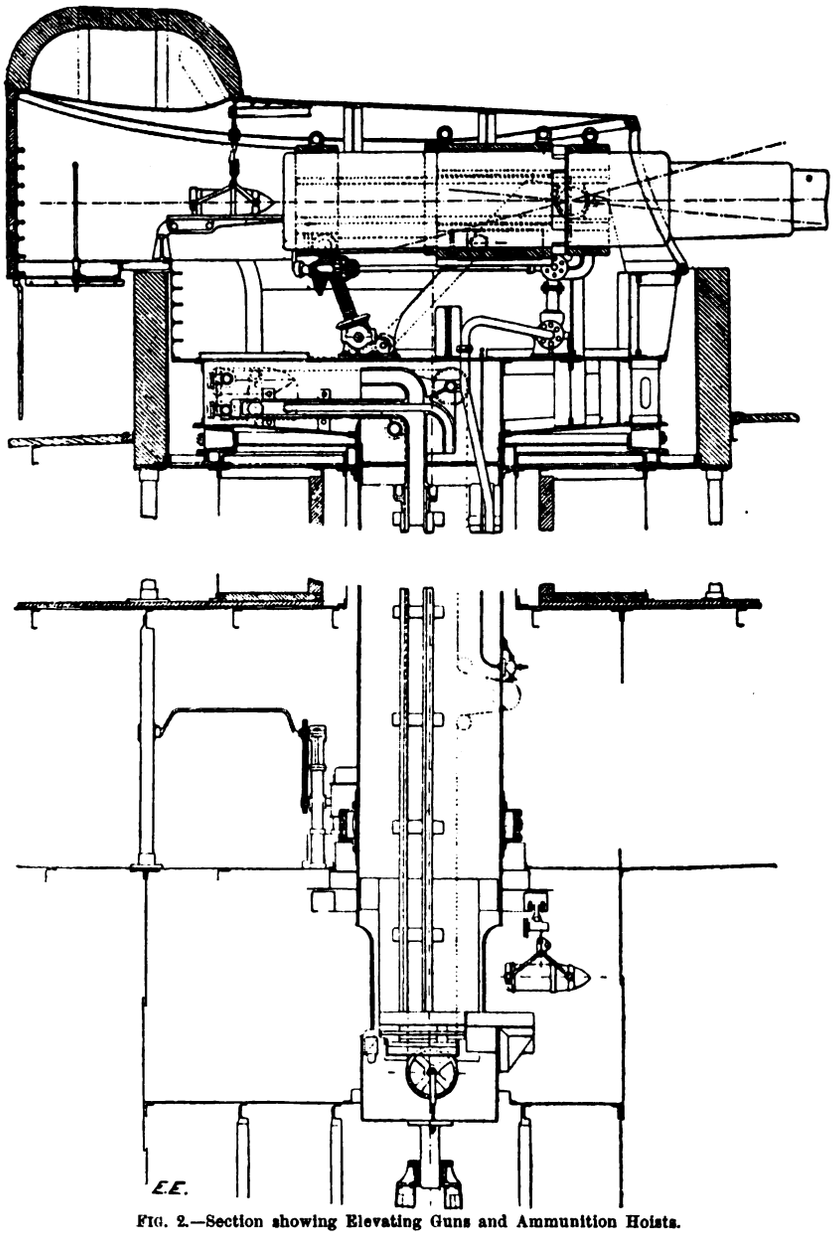

FIG. 2.—Section showing Elevating Guns and Ammunition Hoists.

vessel, eight 4¾in. quick-firing guns, 16 Hotchkiss guns, five gatlings, and four torpedo tubes. The construction of the turrets will be readily seen from the illustration. Two motors connected parallel on the electric mains are placed a little distance from the central tube on a special base-plate. They work by means of spur gear, the one driving the revolving gun platform, and the other the elevating gear. The first motor is capable of developing 650 foot-pounds per second with 15 amperes, and the other 565 foot-pounds per second with 12 amperes. This last power is more than sufficient for the purposes to which it is applied. But to turn the barbette which contains and protects the gun, the power of the first motor had to be augmented to 2 h.p. The distribution and regulation of the current to this motor is effected by hand rheostats placed on the moving platforms. The gunner is thus able to train the gun without taking his eye off the sights.

The current is supplied from four dynamos coupled two to each of two engines, and placed in the engine-room. Each dynamo can give 500 amperes at 70 volts, to be applied at the same time to work the four large guns and the eight smaller ones. Two other similar sets are used for

It consists of a horizontal circular plate, on which are engraved the numbers 1, 2, 3, and 4 on each side of zero, which is the normal position of the handle. These divisions give different speeds of the motor in either direction. Thus, to turn this gun and turret through 270deg. it takes

1 minute	27	seconds	on the	first position.
1 „	17	„	„	second „
1 „	12	„	„	third „
1 „	4	„	„	fourth „

When the correct position has been roughly found, the handle is let go and it returns to zero automatically. The final adjustment is then obtained by means of two keys similar to those used on the Morse instruments. With the fine adjustment obtained with this second arrangement, impulses of $\frac{1}{10}$th to $\frac{1}{15}$th of a degree can easily be obtained. The energy acquired by this great weight (some 87 tons) moving even at a slow speed has to be quickly absorbed when the gun is in the correct position. To do this, and to prevent the gun moving on when the current is switched off, there are brakes provided, but the principal stopping

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effort is obtained by short-circuiting the motors. This short-circuiting is effected automatically. The lifts for the ammunition are worked by separate motors fixed on plates riveted to the central tube, and turning with it. The ammunition carrier is worked by an endless chain, which is automatically stopped when the carrier is at the extremities of its course.

The author states that the gear works most satisfactorily, and that much time is saved by it.

TELEPHONE EXCHANGES AND THEIR WORKING.*

BY DANE SINCLAIR, MEMBER.

In introducing this subject I find that, to give you anything like a clear idea of the working of telephone exchanges as they exist in this country, it will be necessary for me to refer to a few fundamental principles underlying all telephone exchange work, which, however, have been previously explained in journals, text-books, and elsewhere. In all telephone systems there are three branches into which they may naturally be divided—viz., (1) the line wires connecting subscribers' offices to exchanges; (2) the instruments in subscribers' offices; and (3) the switchboards in the exchanges.

With reference to the lines, it is not my intention here to say much in regard to them; although, indeed, the lines now used for telephonic purposes differ very greatly from those formerly used for telegraphic work. It was not until the introduction of the telephone that such subjects as the static capacity and self-induction of lines received so much attention in other than submarine telegraph work. In telephone work, however, these points are of the very highest importance, and necessitate a large amount of attention. We have arrangements working on our telephone lines which, at first sight, would have appeared to the old telegraph engineer to be the worst that could possibly be devised. I have made some experiments on telephone lines, and, under certain conditions, have obtained better speaking results over a line 40 miles in length, on which there was a series of earths, or leakages, than could have been obtained with a well-insulated line. The same applies to metallic circuits, but in this case the leakage is from the outgoing wire to the return. This subject, although interesting, is, however, outside the scope of my present paper.

Broadly speaking, all the calling instruments now used in this country in subscribers' offices are those known as the magneto pattern, and there is fitted along with each a transmitter, battery, and receiver, the whole forming a complete set. It is, however, the switchboards at the exchanges that I wish specially to bring before your notice to-night. The diagram at Fig. 1 shows the connections which, with certain modifications, are made on all kinds of switchboards. The apparatus includes a line jack, marked J, and an indicator, marked I, through both of which the circuit passes either to a general earth wire, or, in the case of metallic circuits, to a return wire. I may explain that what is called a "jack" is that part of the apparatus into which the connecting plug is inserted. When any two lines are to be connected together, two of these plugs are inserted into the two jacks of the lines concerned, the plugs being connected together by a flexible conducting cord. It is our usual practice in this country for small exchanges—of, say, under 200 lines—to make up the switchboard in sections of 50 lines. The drawing at Fig. 2 shows the type of section which has been adopted by the National Telephone Company for general use in these small exchanges. In its main principles it is the same as other small standard boards, but special attention has been given to the details; facilities have been provided for connecting the line wires to the switchboard, and all the working parts have been covered so as to exclude dust as much as possible. A further reference to Fig. 1 will show that here, as before described, the line passes through the jack and indicator and back by the return wire. Cords, similar to the one already mentioned, are fitted on a shelf, each cord having a pulley and weight to bring it back to its proper place when out of use. A ring-off indicator is also provided, which can be put in bridge across the cord by means of the key designed for that purpose. This key is shown at Fig. 3†, and by it the operator can also throw her telephone into or out of circuit as required. A separate pair of keys is provided to enable the operator to ring on either of the lines she is connecting. The ringing current is, as a rule, produced by a small generator driven by an electric or other motor. These listening keys and ringing keys are now universally used by the National Telephone Company, and are all of the standard patterns shown. When a subscriber turns the handle of his generator the shutter of his indicator in the exchange drops and shows his number. The operator then inserts one of the plugs of a double cord into the jack belonging to this line, and asks the subscriber what he wants. When this information is received, the operator inserts the plug at the other end of the cord into the jack of the line wanted, and completes the operation by turning the lever of her key, which cuts her telephone out of circuit and brings in the ring-off indicator. This indicator, as before mentioned, is now connected across the line in bridge in the case of metallic circuits, or tapped to earth in the case of single wires. This indicator is of a special type, being wound to a resistance of 1,000 ohms, and placed inside a tube of soft iron, so as to give it large self-induction and cause great impedance to the passage of telephone currents, which are, of course, of high frequency. The object of this indicator is to show the operator when subscribers have finished their conversation. When this signal is given to the operator, the plugs are withdrawn and everything restored to its normal condition. As the subscribers' indicators are cut out of circuit when their lines are connected as described above, they are of the ordinary type, and are wound to a resistance of 100 ohms. In addition to the type of board already mentioned, shown at Fig. 2, we have used in this country very largely, for small exchanges and for private installations, a class of switchboard known as the "single-cord" board. In this pattern of board a cord and plug are provided for each line, and, as shown on the drawing (Fig. 4), the lines come to the outer springs of the jacks, and, without breaking, pass to the cord and terminate in the plug. In addition to this, a high-resistance indicator, of the same type as the ring-off indicator previously described, is provided for each line. To make a connection the plug of the line of the calling subscriber is inserted into the jack of the line wanted, leaving the indicator of the first line in circuit, and, as will be seen in Fig. 4, the indicator of the second line is cut out of circuit. For working this class of board, the operating instruments is provided with a plug for answering the calling subscriber and for ringing the subscriber wanted.

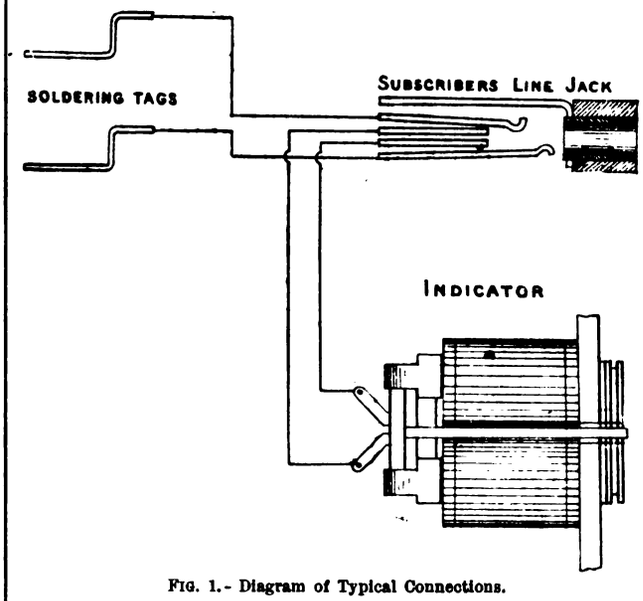

FIG. 1.- Diagram of Typical Connections.

It will be readily understood from what has been said that as exchanges increase in size the switchboards become too large for the operators to be able to reach to make all the connections. In the earlier days wires were run between the various sections of the board for the purpose of connecting the different groups of subscribers' wires together. At this point commenced the difficulties of telephone exchange work, because there was no certain method of showing to the operators in the exchange when any subscriber's line was engaged, and also because the first operator had not complete control of the connection, and, consequently, it was liable to be interfered with by the second operator. In practice this became a very serious trouble. A remedy was found by our friends on the other side of the Atlantic, where they had to deal with the question of large exchanges earlier than we in this country. To overcome the difficulty they invented what is known as the "multiple" board, the possession of patents for which must have given the owners very considerable satisfaction, as well as yielded them enormous profits. In this connection I may mention that the multiple system was independently invented by an employé of the United Telephone Company, but subsequently to the date of the American patent. The multiple switchboards used generally in this country are made up of the required number of sections, each containing all the apparatus necessary for 200 lines. Each section is 6ft. 6in. in length, and is subdivided for four operators, each

* Paper read before the Institution of Electrical Engineers last night.

† Figs. 3, 4, and 5A will be given with the remaining portion of this paper.

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having 12 pairs of connecting cords, with the usual equipment of listening and ringing keys of the type shown at Figs. 3 and 5A. In addition to the full equipment of apparatus necessary for 200 lines, each section is also fitted with jacks, through which all the lines in the exchange pass. On this principle the number of jacks necessary in an exchange increases in an amazing manner. For instance, an exchange with 400 subscribers' wires would require only 800 line jacks—*i.e.*, the 400 lines in the exchange would come to jacks on section No. 1, and be repeated on section No. 2; but if we consider an exchange of 5,000 subscribers' lines under similar conditions, we find that there would be 25 sections of 200 lines each. As in the case of the two sections mentioned, the line jacks would be repeated on each of the 25 sections (5,000 on each), making a total of 125,000 line jacks. In practice every exchange is provided also with junction wires to other exchanges, and many of them with trunk wires to other towns. The junction wires are divided into two approximately equal groups, one carrying tho outgoing and the other the incoming traffic. To render the outgoing junctions accessible to all the operators, they are, like the subscribers' lines multipled on every section. Incoming junctions do not require to be multipled, but special sections are provided for working them, and these also contain a multiple of all the subscribers' lines. As it is found in practice that an operator cannot attend to more than 25 of these junction lines, each section, with four operators, will accommodate 100 junction lines. *(To be continued.)*

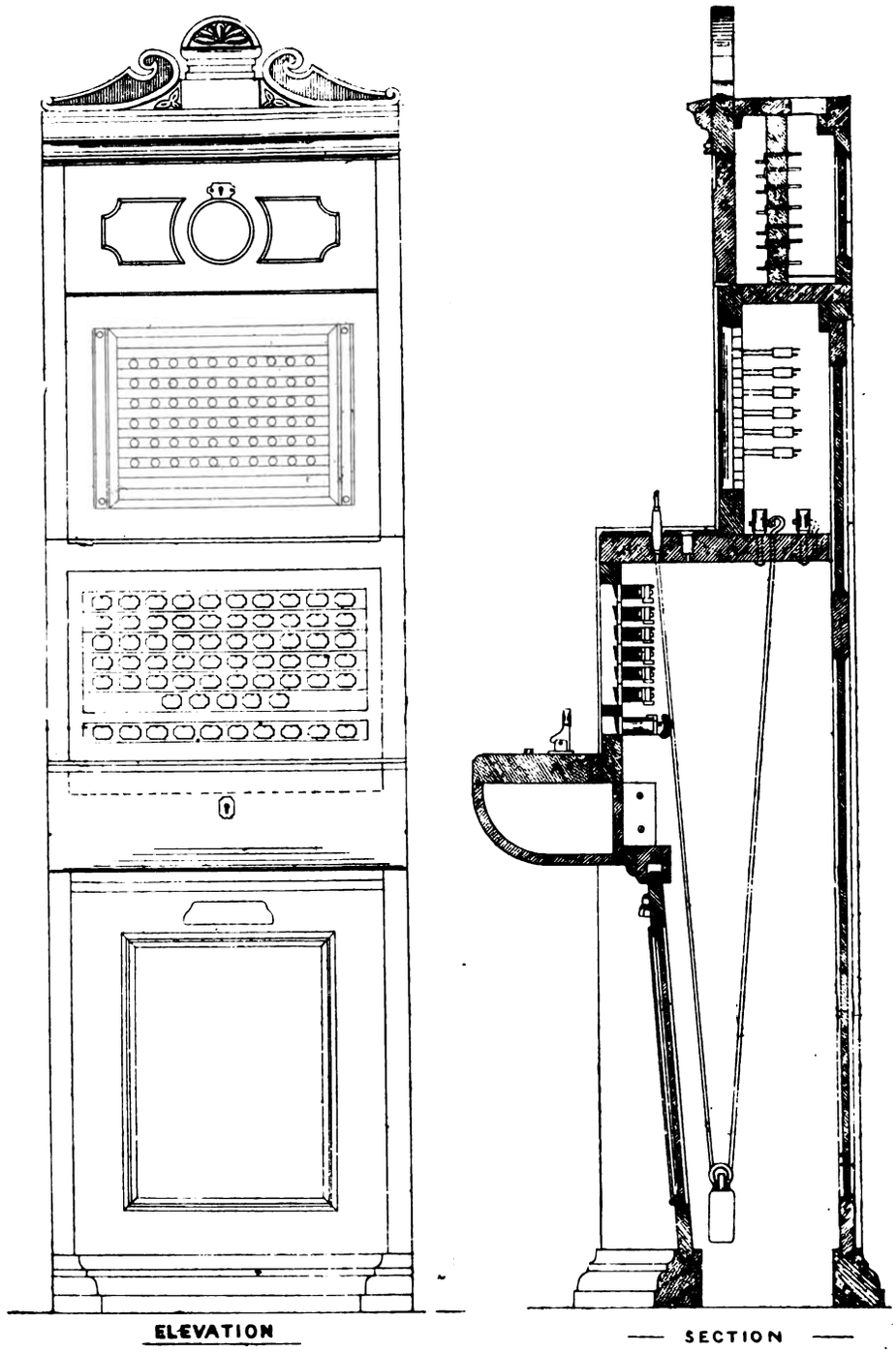

FIG. 2.—Switchboard for Small Exchange of Fifty Subscribers.

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 12.

At last night's meeting of the Institution the following candidates were balloted for:

Members.—Thomas Topham Hardaker and R. W. Weightman, Government Telegraph Department, Pietermaritzburg, Natal.

Associates.—Gabriel Andreoli, "The Acacias," 147, Cold Harbour-lane, S.E.; Captain Mossom Archibald Boyd, R.E., 3, The Esplanade, Plymouth; Ernest James Cochrane, care of Westralian Electric Light Supply Company, Coolgardie, West Australia; Philip Henry Dawe, 4, Cranbury-place, Southampton; Léon Gaster, 37, Maida-vale, W.; Harold Hastings, 5, Oakley-street, Chelsea, S.W.; Samuel Thomas Pemberton, 36, Hornsey Park-road, Hornsey, N.; Edward Gould Tillyer, "Dunedin," Mottingham, Eltham; William Robert Clapcott Walkley, 67, The Grove, Hammersmith, W.

Students.—John Arthur Hotham Clifford, St. John's Hill, Ellesmere; H. F. Hesse, 23, Montague-road, Richmond, Surrey; Reginald Wilson Gauntlett, 23, Dartmouth Park Hill, N.W.

Electrical Engineering in Hungary.—An electric power transmission plant is being installed by Messrs. Siemens and Halske, of Vienna, at the gold mine of the Ruda-Zwolfapostel Gowerkschaft, at Brad, near Deva, Hungary.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XV. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

THE GOVERNMENT AND ITS CONTRACTORS.

It may seem like thrashing a dead horse to call attention to questions pertaining to governments, contractors, and working drawings. The subject, however, is both important and painful. Quite recently questions have been asked in Parliament and communications have appeared in the papers in connection with certain working drawings relating to torpedo catchers. It seems the custom of the Government, or at any rate the Admiralty, is to insist upon a set of working drawings from the contractors. When a new departure is being made this custom works out disastrously to the contractors, for the subsequent action of the Department is to hand the working drawings over to competitive contractors, and upon them to invite tenders. It is probably an exceptional case for a first order to pay, especially when the contractor has largely to be a designer and inventor. Take the especial case that has caused so great a commotion. The builders of fast-speed ships in the first instance did not work to rigid specifications; they suggested and made alterations both to vessels and machinery, with the result that something superior to anything existing before was produced. Having achieved this success, not by merely building to specification, but by the use of brain power, skill, and experience—by the use, in fact, of items that cannot be scheduled at so much per hour or so much per weight in a list of prices, the contractors naturally expect that, having obtained what was wanted, their efforts would be recognised by repeat orders. Nothing of the sort, however, happens. The talented men see their designs sent broadcast to competing firms, and these firms are asked to tender for the repeat work. The chances are largely against the original builders getting the further contracts, and hence against their getting any return for their original work. If specifications and drawings were always sent out in a perfect state from the Admiralty, there would be little to complain about. The original work would then be done by their own engineers, and the contractors would be merely contractors, and nothing else. We should hardly have any reason to complain of this state of things were the matters under discussion restricted to ships and steam-engines only, but, with all reserve, we are bound to state that the trouble goes far beyond—it is as wide as the requirements of the various departments. There is hardly a single matter of detail, say, in regard to electrical apparatus, that has not been largely benefited by the work of contractors. Their skill, knowledge, and experience has been used in order to produce the apparatus. It is no mere fulfilling an order that we refer to, but the successful construction of a new piece of apparatus. The construction may fail; on the other hand, it may succeed, and the success may be due wholly to the work of the contractors. Just what has happened in regard to fast-speed ships has and does happen in regard to electrical apparatus. The working drawings for further requirements are sent to other than the original contractors, and now that the thing can be specified with exactness, every

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firm receiving the specification is reaping the benefit of the original firm's work to that firm's loss. It is a very easy matter to show the unfairness of such a system, but it is as difficult a matter to suggest an efficient remedy. The Government cannot very well guarantee to restrict its purchases to one firm only. That remedy would be worse than the evil. We can only suggest a give-and-take method. The large Government departments ought to be able to command the unbiassed views of experts. The experts ought to know whether a suggested construction is in the shape of a new departure or not; they ought also to be able to appraise a value to the successful construction of new apparatus without being niggardly or lavish. The military and naval authorities of the kingdom are compelled to act in a progressive manner, and frequently in an arbitrary way, but there is no reason why they should not act justly. No one can defend the obtaining of original working drawings to the detriment of the designer. The country does not wish to obtain anything without suitable remuneration, and it is therefore for those in authority to enquire carefully into all these questions and arrange for just consideration to be given for work done.

REVIEWS.

Applied Magnetism. By J. A. Kingdon, B.A. H. Alabaster, Gatehouse, and Co., 22, Paternoster-row, E.C.

This book, which is to serve as an introduction to the design of electromagnetic apparatus, is one which can be highly recommended to all students, and to those who have only a practical knowledge of their profession. The matter is treated in a lucid and complete manner, and bears the stamp of original thought. The following is the progressive order of the information given. Commencing in the first chapter with a description of the general principles of magnetism, the author passes on to consider electromagnetic units, magnetomotive force, tractive force, generation of E.M.F., and qualitative magnetism, before broaching the general applications. The remaining two-thirds of the book is devoted to the practical use of magnetism, and gives the general formulæ for the design of alternators, dynamos, and other magnetic machinery. The matter is necessarily condensed, but this is a distinct advantage when the reader uses the book as a preliminary treatise before specialising. The question of sparking at the commutator is well gone into, but, although the author's grasp of the subject is clear, we hardly like the following sentence on page 185, that "the essential point in the design of a dynamo is to effect the commutation under such conditions that the commutated coil has no self-induction." The matter is explained afterwards, but the fact that the self-induction must be neutralised is not conveyed by the above statement. Another point overlooked in the calculation of the hysteresis loss in the core of an armature is the fact that the maximum induction is considerably higher than the mean when the dynamo is loaded. The main point, however, in which we think the author should have used more care is in the choice of his symbols. His treatment is distinctly orthodox, but his symbols are not. Thus, he calls a C.G.S. line a mag., but uses M for magnetomotive force. Again, R is used for resistance and revolutions per minute in different parts of the book, so that the student in his list of formulæ cannot tell which is which. Afterwards r is also added for revolutions per minute. Again, f is used for both magnetic flux and for frequency, and hence a reader could obtain an f^2 in the transformer equations. To avoid this the author uses p for frequency, although this letter in other places signifies the number of poles in an alternator and also the power in watts. The letter C is ubiquitous in its application, but the climax is reached when C = the current in a wire in the armature, and the horse-power is then $\frac{2CE}{746}$.

One other example will suffice, and that is the use of L, the accepted term for self-induction, or magnetic reluctance. We know that an intelligent student is not hampered while confining his studies to this volume only by these uses of the common symbols, but the redundancy of meaning is even then confusing, and his further studies would in any case be more difficult. The printing of the book and the illustrations are excellent, and the collection of the symbols and formulæ at the end would be most useful with a rearrangement of symbols.

Electric Wiring. By Russell Robb. Macmillan and Co, New York. 10s.

This well-edited book is intended for the use of architects, underwriters, and the owners of buildings. The author has not therefore attempted to deal fully with all the principles of electrical engineering, but has endeavoured to supply an everyday knowledge which will certainly be useful to the people for whom the book is written. The national code of rules for electric wiring are given in detail, followed by an explanation of the *raison d'être* of each rule. Hence the book is much more useful to America, as 123 pages out of 177 are devoted to these rules, which are not applicable in England. The first four chapters, dealing with the various electrical units, the proportioning of wires, and systems of distribution, are more universally applicable. Some of the analogies used are rather strained to meet the case in point, but, on the whole, the reasoning is concise and clear. We recommend this book to those who wish to understand the regulations in force in America, where wider latitude is allowed in wiring construction than in England.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

March 27, 8 p.m.—Students' meeting. "Closing a Dock Entrance for Repairs," by J. S. Wise, Stud.I.C.E.
March 31, 8 p.m.—Ordinary meeting. "The Tampico Harbour Works," by Dr. E. L Corthell, M.A., M.I.C.E.

Institution of Electrical Engineers.

March 28, 8.30 p.m.—Students' class. Visit to Amberley-road, Manchester square, and Sardinia-street central stations of Metropolitan Electric Supply Company. Assemble at Amberley-road.

Institution of Junior Engineers.

March 28, 7.30 p.m.—Conversazione at Westminster Palace Hotel.

Royal Institution of Great Britain.

March 27, 9 p.m.—"New Researches on Liquid Air," by Prof. Dewar.
March 28, 3 p.m.—Last lecture on "Light," by Lord Rayleigh.

Physical Society.

March 27, 5 p.m.—At Burlington House. "The Electromagnetic Effect of Moving Charges," by G. W. Morton. "The Edison Effect," by J. A. Fleming.

King's College Engineering Society.

March 27, 4 p.m.—Terminal business meeting.

Electro-Harmonic Society.

March 27, 8 p.m.—Smoking concert, St. James's Hall Restaurant.

City of London Electric Lighting Company, Limited.

March 31, 7.45 p.m.—The staff's fourth annual Bohemian concert, Cannon street Hotel.

SMALL DOMESTIC TELEPHONES.*

The firm of Töpffer and Schadel, Berlin, now construct for small installations miniature telephones, which, if they act as well as they are said to do, ought, by reason of their handiness, to be of service for hotels, hospitals, factories, ships' cabins, etc. Designed to look like the pear presses

* From *L'Electricien*.

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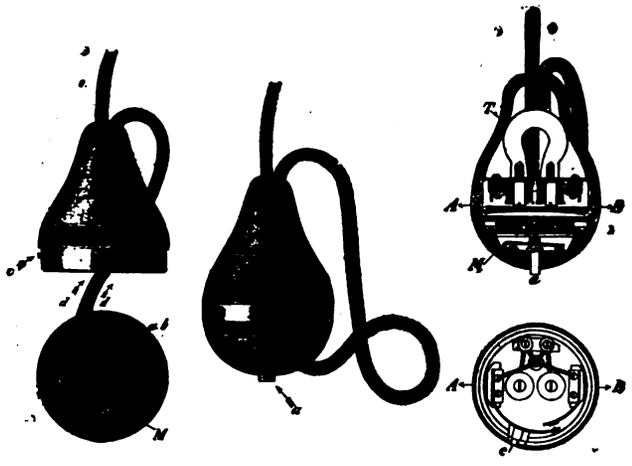
of electric bells, they do not disfigure the decorations. The telephone will be very useful for invalids, who will find it handy when they need to call for assistance. The apparatus, as represented in the above illustrations, can be suspended anywhere. It is cased in vulcanite, wood, or aluminium, and weighs about 100 grains. It is shown in two sections, one axial, the other through A B. The upper part contains the telephone, T; the lower part the microphone, M. They are connected by the flexible wire, *d d*, or they can be joined up separately if wished. The perforated plate, *b*, serves to protect the microphone; the button, *a*, rings a bell. The telephone, T, is composed of a powerful horseshoe magnet with bobbins of wire on it. The microphone is formed of a corrugated carbon disc and grains of carbon. When the receiver and transmitter are joined, contact is made by pressing the little button, C, which puts the telephone in circuit and rings the bell. This done, the two parts are separated; the ear is placed to the



telephone and the mouth to the microphone, and conversation can be carried on, the contact, C, automatically retaining the telephone in the circuit.

THE REGULATION OF PRESSURE AND THE REDUCTION OF LIGHT-LOAD LOSSES IN ALTERNATING-CURRENT SYSTEMS OF ELECTRIC SUPPLY.*

BY E. W. COWAN AND ALFRED STILL.

On account of the greater facility with which the pressure can be maintained on a system of distribution when the supply is a high-tension one, provision for its regulation has come to be somewhat neglected in this country. The standard of permissible variation of pressure with a low-tension system has not been a high one, and because with a high-tension supply it has been found easy to improve upon this, few efforts have been made towards the attainment of a higher standard. But with the heavier loads of to-day, and the advantage of our more complete knowledge of alternating currents, we should not rest satisfied with so low a standard; and complaints from consumers connected to the tail end of long distributors of the falling off in their light at times of heavy load when its full brilliance is most desired, should belong to the history of the past. We can do better, and we ought to.

The object of the first part of this paper is to set forth what we believe to be the best methods of maintaining constant pressure in all parts of a distribution system under varying conditions of load. The first point to which attention must naturally be paid is the arrangement of the mains and transformers. This subject has already been dealt with to some extent before this society by Mr. Clirehugh and Mr. Rider, but as each district must be considered on its own merits, it is not possible to formulate any definite rules. There are perhaps four systems open to us: (1) high-tension distributors with transformers on consumers' premises; (2) feeders in connection with high-tension distributors and transformers on consumers' premises; (3) feeders with transformers in sub-stations and low-pressure distribution; (4) feeders with transformers in street boxes, and both high and low tension distributors. From the point of view of the subject of this paper—viz., the regulation of pressure—the first of the above systems is the worst and the last one the best. It is on the relative advantages of the third and fourth systems that we should like to offer a few remarks.

Sub-stations with banks of transformers have become very popular; but we are inclined to think that their advantages are somewhat overrated, and that a cheaper, and in some respects more efficient, arrangement is to space out the transformers under the footway in the manner indicated at D, in diagram No. 1. With this arrangement a much better regulation can be obtained than the low-pressure distribution system shown at C. It has the further advantage of simplicity in the first laying of the mains when the distribution of the load is uncertain. Most of us have been surprised when a station has been running for some time to find that our lamp connections have not distributed themselves according to our expectations, and that we have heavy cables lightly loaded and light cables heavily loaded. With this system, it is simple and inexpensive to lay both high and low tension cables of large enough capacity for the ultimate requirements of the district. The transformers, which may be of uniform size, are fixed according to the position and amount of load as it arises, the final result being that

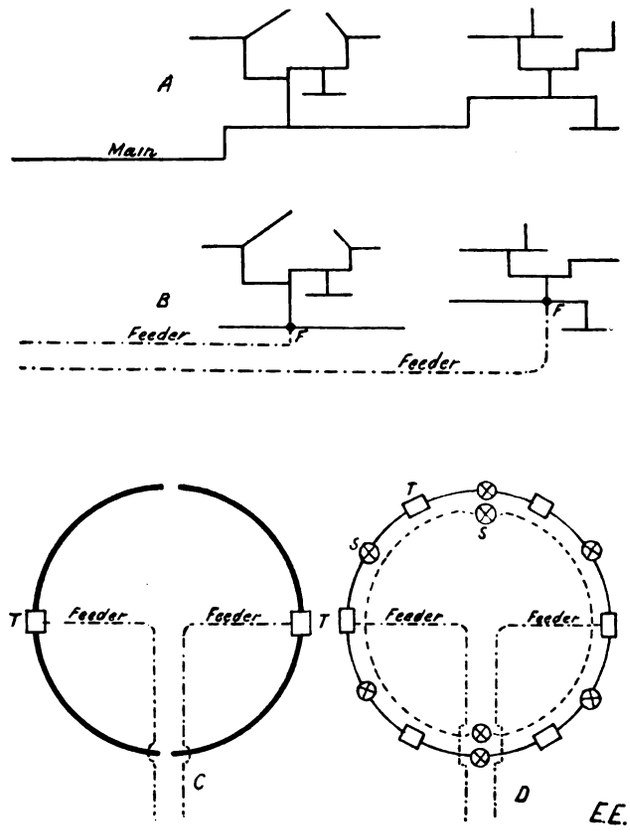


DIAGRAM NO. 1.

transformers are close together where the load is heavy and comparatively remote in those positions where the demand is small. It may be argued that many transformers of a small size cannot be so efficient as a small number of larger size; but 12 to 15 kilowatt transformers may have a very high efficiency, and they are more readily handled than the very large sizes often fixed in sub-stations. If underground switches are arranged to connect the low-tension service mains of one transformer to those of the transformers on each side of it when required, it will be possible to remove a transformer without interfering with the supply. And if similar switches are fitted at intervals in the high-tension main, a fault in the cable can readily be cut out and the supply continued in the whole district fed by this main, with the exception of the particular length which contains the fault. Such underground switches can be made at a low cost, and will work quite satisfactorily. Whatever system may be adopted, it is certain that feeders will form part of it, and the important question arises as to what cross-section they should have. Apart from the question of regulation, there can be no doubt that they should be proportioned in accordance with Thomson's law. But here a difficulty arises: the loss of pressure will be frequently be so great that at times of full load uniformity of pressure cannot be maintained at the feeding points unless all the feeders are of the same length and subject to corresponding fluctuations of load, a condition which does not obtain in practice. It follows, therefore, that a regulating device must be connected to each feeder, preferably at the generating station end, or inequality of pressure at the feeding points will result; the other alternative being to lay feeders, which are uneconomical on account of their large cross-section and corresponding

* Paper read before the Northern Society of Electrical Engineers, March 23, 1896.

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first cost. Mr. Crompton, we think, makes too much of "efficiency of distribution," this being a question which cannot properly be dealt with except in connection with first cost.

We propose now to describe a simple graphic method of determining the sectional area of feeders according to Thomson's law, as the usual formula needs some modification to adapt it to cables of which the insulation bears a large proportion to the total cost, and which do not carry a constant load. We will afterwards deal with the various regulating devices which are available at the present time for compensating for the drop on the feeders.

Feeders.—The most economical cross-section for a feeder depends upon two things only: the first cost of the cable and the cost of production of the energy lost in it on account of its ohmic resistance. Thomson's law, which takes into account the annual cost of the watts lost in the conductor, and the allowance for depreciation and interest on first cost of the cable, may be expressed as follows: The most economical section of a conductor supplying electric current to a distance is such that the annual allowance for interest and depreciation on original cost of the cable will be equal to the annual cost of the energy wasted in overcoming its ohmic resistance. The cross-section should therefore be determined solely by the current which it has to carry, and not by its length, or an arbitrary limit of the percentage full load drop in pressure—the drop, even if considerable (and it is not likely to be so on a high-tension system), must take care of itself. There are possibly two reasons why Thomson's law is not more generally followed in calculating the sizes of feeders for systems of electric light supply: (1) because it applies only to bare conductors, of which the cost per mile may be taken as being proportional to the weight of the copper, and therefore to the cross-sectional area; and (2) because it assumes the current to be constant from one year's end to the other, a condition of things which unfortunately has not been realised by electric supply stations. Although Thomson's law, in its usual form, is not directly applicable to existing conditions, the spirit of it should never be deliberately neglected. All that we have to attend to is this—to see that annual cost of the energy wasted in a mile of the feeder, added to the annual allowance (per mile) for depreciation and interest on first cost, shall be a minimum. With regard to the question of varying current, this is easily dealt with. The energy lost in a given cable depends upon the square of the current and the time during which the current is flowing. If a cable conveys a current, C, only 12 hours out of the 24 hours, then the energy wasted per day is only half what it would have been had the current been flowing continuously, and the watt-hours may be expressed as $12 \times C^2 \times R$, or as $24 \times \frac{1}{2} C^2 \times R$, and it is evident that in working out the energy lost per annum in the cable, we have to multiply the resistance, not by the square of the maximum current which the cable will carry, but by the mean value of the squares of the current during the year.

From measurements taken on actual load diagrams it would appear that, in the case of electric light supply stations having a small all-day load, the full load or maximum current is from two to three times as great as the mean square value of the current taken for the whole year; this proportion depending upon whether the capacity of the feeder is appreciable or not, and also upon the nature of the districts supplied. It is evident that this multiplier can easily be worked out from a few typical load diagrams. The following example and the Diagram No. 2 will make it clear how the proper size of cable may be worked out in actual practice. And first it should be understood that it is the cost of the cable only on which the percentage for interest and depreciation should be taken, because the cost of trenching and laying, or drawing into pipes or culverts will be practically constant, and unaffected by the exact cross-section of the copper in the cable. Let us suppose that 10 per cent. is to be allowed for depreciation and interest on capital spent; then, in the Diagram No. 2, where the horizontal distances represent resistance in ohms, and the vertical distances represent money, plot the curve A, which gives the relation between 10 per cent. of the cost per mile of the cable (taken from the maker's price-list) and its resistance in ohms per mile (go and return)—this curve, which has been plotted from actual prices for concentric cables by a certain firm of well-known manufacturers, is not a rectangular hyperbola, as it would be if Thomson's law were to hold good. The dotted curve is a true hyperbola or the curve which makes the cost universally proportional to the resistance of the cable, and inspection of these two curves will show how the cost of the (insulated) cable is proportionately greater for the smaller sizes. Now calculate the cost of the $C^2 R$ losses per mile of cable for any particular value of the resistance, and draw the straight line, O B, which will give us this cost for any other resistance of cable. In this diagram the losses have been calculated on the assumption that the current is 26 amperes, and that the cost of production is 1½d. per unit. It is evident that this must be taken on the low side, as during the lifetime of the cables the works cost per unit may be expected to be reduced. By adding the ordinates of the curves A and B, the curve C is obtained, whose minimum value corresponds with a resistance per mile of ·78 ohm. The nearest cable to this (on the small side) is $^{19}/_{14}$, and this, if the cost of production of electrical energy and the probable current have been estimated correctly, is the proper size of cable to use, whatever may be its length or the voltage required at the feeding point. Assuming the maximum value of the current to be three times the square root of the mean square value, and the length of the feeder to be one mile, the "drop" at full load would be $78 \times \cdot 91 = 71$ volts.

Capacity.—The effect of capacity in a system of concentric mains is to increase the current entering the cable at the alternator end, although the current leaving the cable at the far end will, of course, depend only on the pressure and lamp load at that end. In the long concentric feeders the capacity current should therefore be taken into account, especially as its effect in increasing the total current is more marked at light load than at full load. It is easily calculated with sufficient accuracy by the formula $C = 2 \pi n K V$,

where K = the capacity in farads;
n = the frequency in periods per second;
V = the mean voltage.

It must be remembered that this current is not in phase with the main current, but quarter period in advance of the impressed

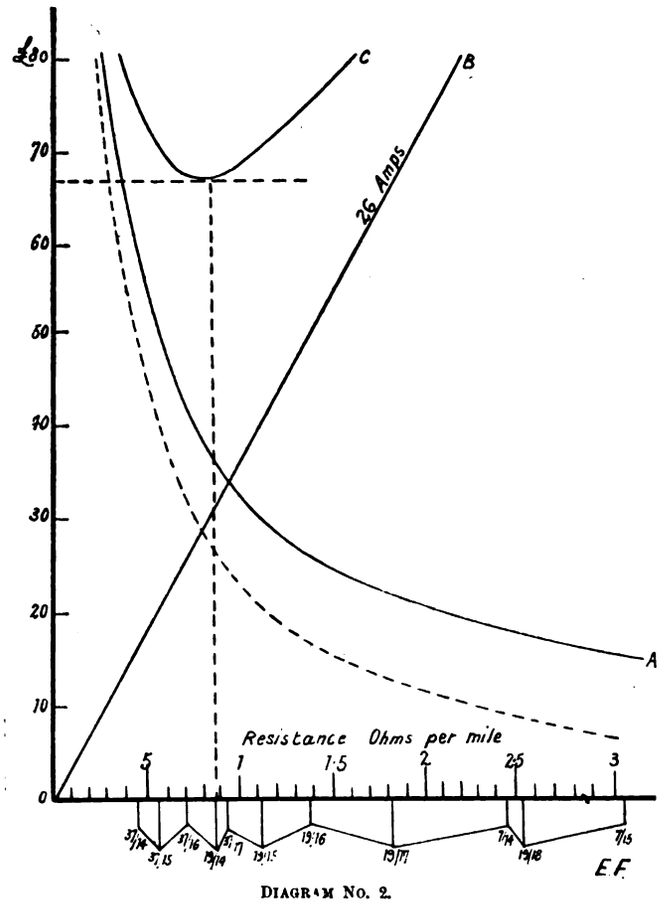

DIAGRAM No. 2.

volts. Hence, if C = 10 amperes, this will be the current indicated by the feeder ammeter on open circuit. At full load, with 60 amperes taken out at the far end, the current read on station ammeter will be the square root of $60^2 + 10^2$, or about 61 amperes. The following capacities of concentric cables have been kindly furnished us by the makers, and may be found useful in estimating the probable value of the capacity current in a given system of mains. Capacities per mile (inner to outer) of $^{19}/_{18}$ concentric cables: British Insulated Wire Company (paper), ·31 microfarad; Glover and Co. (vulcanised rubber), ·615 microfarad; ditto (diatrine), ·315 microfarad.

Drop on Feeders.—Having fixed the cross-section of the feeders and calculated the full-load "drop," it will generally be found that the latter is considerable on the long feeders and inappreciable on the short. Some methods of dealing with this difficulty must therefore be adopted which will allow of each feeder being independently regulated, as, if we raise the pressure of the 'bus bars to compensate for the drop on the long or heavily-loaded feeders, we shall be at the same time increasing the pressure at the feeding points which are nearer the generating station or at those which are more lightly loaded. There are three methods of effecting the desired result, all equally efficient in respect to regulation, but differing widely in their efficiency in respect to economy: (1) raise pressure of generators until 'bus-bar pressure equals that required for the feeder with the largest drop, and switch more

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or less resistance into all the other feeders to absorb the consequent excess of pressure above that required; (2) same as above, but use variable choking coils instead of resistances; (3) adjust pressure of generators until 'bus-bar pressure equals that required for the feeder with the least drop, and by means of a special induction apparatus add pressure as required to the remaining feeders.

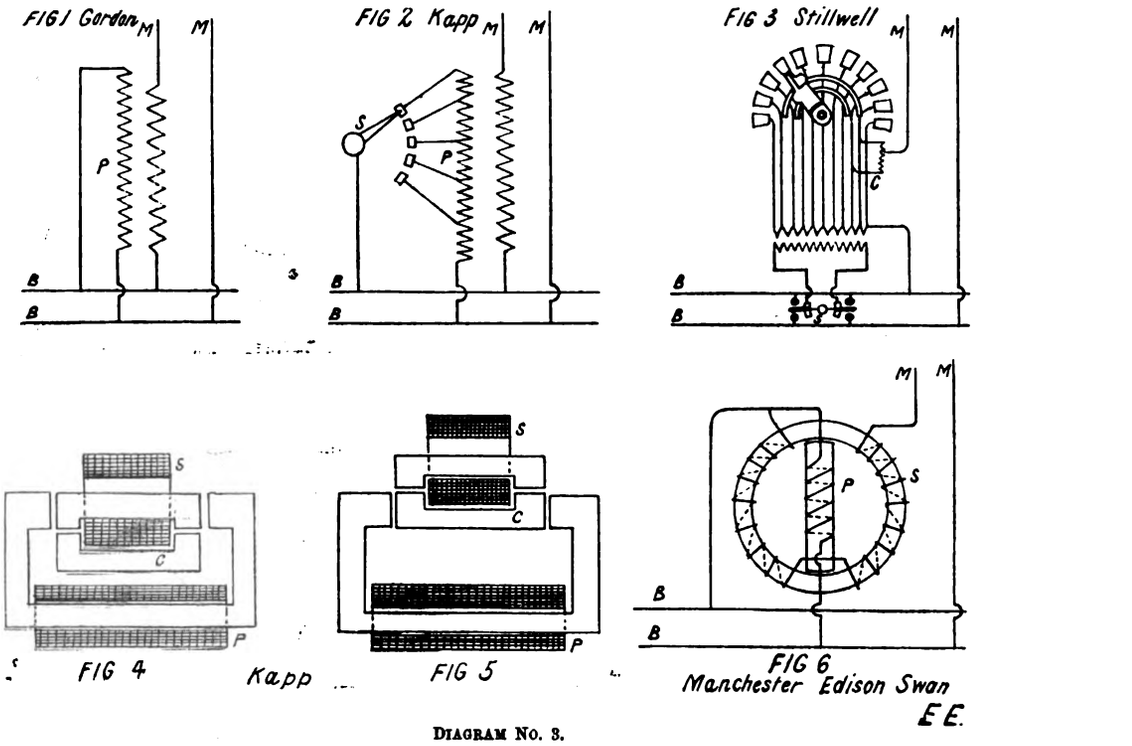

DIAGRAM NO. 3.

Very few words will be required to show the great economical advantage of the third method over the two others. In the first plan the resistances dissipate energy which has cost fuel to produce, and so rob the station of a percentage of its output at the time of maximum load—a serious disadvantage in itself. The second plan is much more economical than the first. But choking coils are not like transformers, the induction and consequent loss in the iron being very much higher on account of the E.M.F. of self-induction being quarter period out of phase with the main current. For a 10 per cent. reduction of pressure the amount of the induced volts will be over four times the volts deducted. But apart from this it will be readily seen that the generation of the E.M.F. by the dynamo and its subsequent destruction by the choking coils cannot be an economical arrangement, accompanied as it must be by the losses of a double operation. The third plan is free from the above objections. The volts required to compensate for drop are added when and where required, and the generators, being worked at a low pressure, work more economically. Without analysing the question, common sense tells us that such a plan is better engineering. When we want to light a part of a building we do not think it right to switch on all the lamps and screen the light from those parts not needing illumination, and there is no more reason for regulating feeders upon a similar principle. The use of a regulating transformer for this purpose was first brought under our notice by Mr. J. H. Rider, who designed and specified such an arrangement for the Bolton Corporation electricity supply station. The principle was not, however, new, and it may be of some interest to trace its development. As far as as we have been able to ascertain, the late Mr. J. E. H. Gordon was the first to make use of the idea of augmenting the E.M.F. of a circuit by connecting in series with it the secondary coil of a shunt transformer. In Diagram No. 3 this plan is illustrated. He termed the apparatus a "hitcher-up." Fig. 2 on the same diagram shows a feeder regulator designed by Mr. Gisbert Kapp; this apparatus is the same as Gordon's, but is provided with a means of varying the augmentation. A segment switch is arranged to cut out the primary coils as desired; as the coils are cut out the E.M.F. generated in the secondary is, of course, increased. Fig. 3 (Diagram 3) shows the principle of an apparatus designed by Stillwell, in America, and manufactured by the Westinghouse Company. This design is similar to Kapp's, and was indeed also suggested by him, the only difference being that instead of primary coils being cut out secondary coils are switched in. Figs 4 and 5 at the bottom of the diagram illustrate another design of Mr. Kapp's, which was intended to get over the difficulties of a high-tension segment switch, with its necessary devices to avoid short-circuiting a coil when being moved from one segment to another, and also to get over the objection of the additions to the voltage taking place in jumps, the necessary result of using a segment switch. The principle of its action is entirely different to the others, the variation in effect being obtained by a movement of the iron core. Fig. 4 shows the apparatus in the position of maximum effect, the magnetism created by the primary coil cutting the secondary coil. In

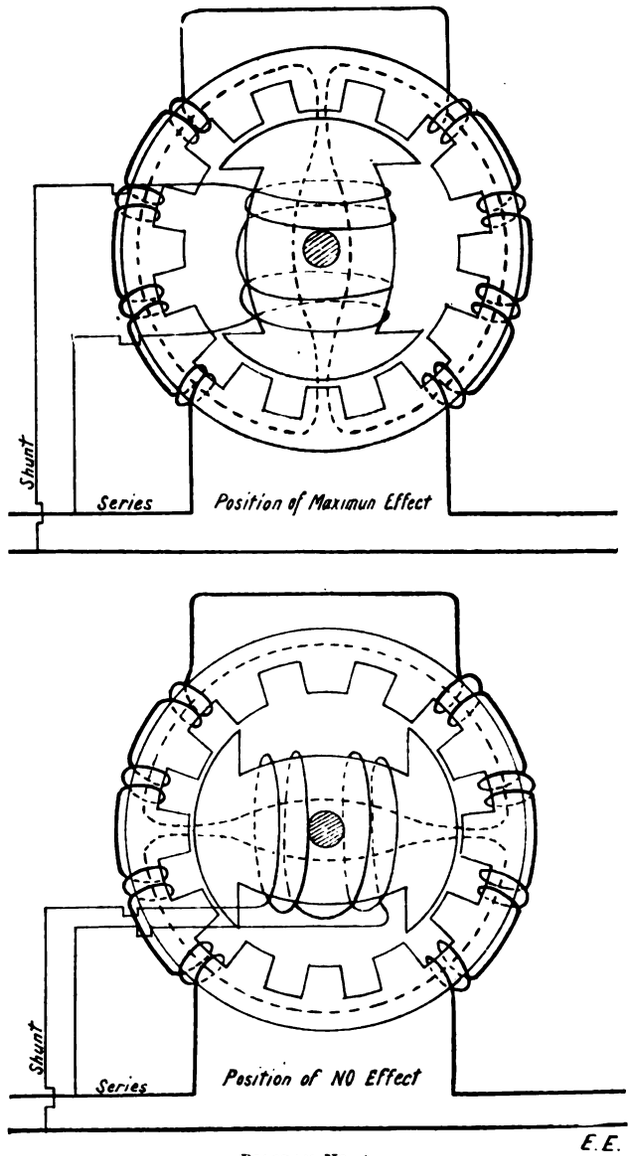

DIAGRAM NO. 4.

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Fig. 5 the core and secondary coil are removed to the position of no effect, the magnetic lines flowing along the core, C, outside the secondary winding instead of through it. We are not aware that this regulator was ever made. It is perhaps scarcely fair to criticise it, but it is apparent that in the position shown in Fig. 5, the self-induction of the secondary would result in a serious loss of pressure in the feeder, and in the position shown in Fig. 5 the magnetic leakage would be appalling.

Fig. 6 (Diagram No. 3 and Diagram No. 4) illustrates the regulating transformer manufactured by the Manchester Edison-Swan Company, Limited, as first made for the Bolton Corporation. In this design the primary coil is wound upon a shuttle-shaped core and the secondary winding upon a ring-shaped core. Between the positions of maximum effect and no effect, the primary coil, with its core, rotates through an angle of 90deg. The action is as follows: In the position of maximum effect the shuttle occupies a vertical position, and the magnetic flux cuts the secondary coil, which is wound in two sections, one on each side of the ring, and generates the full volts required. In the position of no effect the shuttle is horizontal, and the magnetism cuts half the secondary turns in a positive sense and half in a negative sense, the resultant effect being of course nil. Between these two positions any gradation of augmentation can be obtained. It is evident that if the shuttle be rotated beyond the position of no effect (if the transformer is being used as a feeder regulator), volts will be subtracted from instead of added to the feeder volts. The points to which special attention were paid in the design of this apparatus were the constancy of magnetic flux in all positions, the reduction of the iron path to the shortest possible length to avoid iron loss, and the obtaining of a mechanical and compact apparatus which would lend itself to easy and safe manipulation by the switchboard attendant.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS.

We give below the statement of receipts and expenditure for the year ending December 31, 1895, together with the balance-sheet for the same period:

RECEIPTS.

	£ s. d.
Balance in hands of bankers, December 31, 1894, £576. 6s. 2d.; in hands of secretary, 9s. 4d.	576 15 6
Subscriptions paid up for previous years	164 11 6
,, for 1895	2,628 3 6
,, in advance	27 4 0
Entrance fees for 1894	9 0 0
,, for 1895	279 18 0
Life compositions	277 10 0
Publishing fund	2 2 0
Sale of *Journals*	109 4 10
Dividends on stocks—premium fund, £6. 19s.; life compositions, £95. 10s. 8d.; telegraph jubilee fund, £5. 2s.; general investments, £120. 18s. 8d.; Salomons Scholarship fund, £59. 4s. 2d.	287 14 6
Interest on cash on deposit	3 2 7
Advertisements in the *Journal*	81 10 0
Library fund (donation)	4 4 0
Balance due to bankers (after allowing for cheques outstanding)	82 13 7
	£4,533 14 0

EXPENDITURE.

	£ s. d.
Salaries and clerical assistance	800 0 0
Accountants' fees	10 10 0
Shorthand reporter	40 19 0
Attendance, refreshments, and petty expenses connected with evening meetings	57 11 11
Printing, illustrating, and advertising *Journal*, and cost of abstracts	668 8 8
General printing and stationery	157 9 11
Insurance	10 10 0
Purchase of books and periodicals, £8. 2s.; binding books and periodicals, £9. 5s. 2d.; petty expenses connected with the library, £1 18s. 6d.	19 5 8
Office rent, electric light, and firing	328 2 8
Postage of *Journal*, notices of meetings, etc.	269 3 6
General office expenses	51 8 1
Petty expenses of local honorary secretaries	1 14 6
Bank charges	1 6 4
Salomons Scholarship awards	90 0 0
Premiums—Institution Premium awarded to Mr. Mark Robinson, £10; "Fahie" Premium, awarded to Mr. J. E. Kingsbury, £5; Paris Electrical Exhibition Premium, awarded to Prof. Ewing, £5; Students' Premium, awarded to Mr. E. C. Eborall, £3. 3s.	23 3 0
Conversazione expenses (irrespective of printing and postage)	120 11 0
	£2,641 4 3
Purchase of £355. 5s. 10s. Canada 3 per cent. stock, £352. 13s 6d.; and of £133. 10s. Midland Railway 4 per cent. preference stock, on account of life compositions, £199. 11s. 10d.	552 5 4
Purchase of £181 Great Western Railway 4½ per cent. debenture stock, £299 3s.; and of £418 South-Eastern Railway 3 per cent. preference stock, £500. 10s. 2d.; and of £370 London and South-Western Railway preferred ordinary stock, on account of general investment, £500. 19s. 6d.	1,300 12 8
Suspense account (Cooke's manuscripts)*	38 19 2
Balance in hands of the secretary	0 12 7
	£4,533 14 0

* Temporary advance, repayment of which is guaranteed.

BALANCE-SHEET, DEC. 31, 1895.

Liabilities.	£ s. d.
Premium fund	213 0 3
Life compositions	3,272 0 0
Telegraph jubilee fund	163 8 0
Salomons Scholarship fund	2,126 19 3
,, ,, balance of income account	1 9 4
Building fund	3,500 0 0
Subscriptions received in advance	27 4 0
Balance due to bankers, as above	82 13 7
General fund	3,279 18 9
	£12,666 13 2

Assets.		£ s. d.
Investments, "premium fund"—		
£205 3 0 India 3½ per cent. stock		213 0 3
Investments, "life compositions"—		
£400 0 0 New South Wales 4 per cent. bonds	£414 15 0	
318 0 0 Cape of Good Hope consolidated stock	306 0 0	
1,679 19 5 India 3½ per cent. stock	1,776 5 0	
120 0 0 South-Eastern Railway 5 per cent. debenture stock	204 16 6	
355 5 10 Canada 3 per cent. stock	352 13 6	
133 10 0 Midland Railway 4 per cent. preference stock	199 11 10	
		3,254 1 10
Investments, "telegraph jubilee fund"—		
£150 10 6 India 3½ per cent. stock		163 8 0
Investments, "Salomons Scholarship fund"—		
1,500 0 0 New South Wales 3½ per cent. stock	£1,556 5 9	
500 0 0 Cape of Good Hope 3½ per cent. stock	570 13 6	
		2,126 19 3
Investments, "building fund" and general investment—		
£450 0 0 Canada 4 per cent. reduced stock	£475 10 0	
752 18 4 India 3½ per cent. stock	800 0 0	
886 10 0 Midland Railway 4 per cent. preference stock	1,200 0 0	
320 0 0 South-Eastern Railway preferred ordinary stock	511 1 0	
524 13 0 Canada 3 per cent. stock	499 2 6	
181 0 0 Great Western Railway 4½ per cent. debenture stock	299 3 0	
418 0 0 South-Eastern Railway 3½ per cent. preference stock	500 10 2	
370 0 0 London and South-Western Railway preferred ordinary stock	500 19 6	
		4,786 6 2
Furniture—as per last balance-sheet, £214; less depreciation, say, £14		200 0 0
Overdue subscriptions estimated to realise		223 0 0
Stock in hand of Institution *Journals* and Ronalds catalogues, estimated value		497 11 11
Books, pictures, etc. (other than the Ronalds library)		1,093 0 0
Due for advertisements in *Journal*		52 10 0
Suspense account (Cooke's manuscripts)		51 3 2
Cash balance		0 12 7
		£12,666 13 2

COMPANIES' MEETINGS AND REPORTS.

DIRECT SPANISH TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Tuesday at Winchester House, E.C., Mr. Edmund Etlinger presiding.

The **Chairman**, in moving the adoption of the report, first spoke with regret of the serious illness of the chairman of the

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Company, Sir John Pender, and expressed a sincere hope that he might soon be restored to health. During the past year they had earned sufficient money, after deducting not only the ordinary expenses of working the traffic, but some rather expensive extraordinary expenses, to enable the Board to recommend the big dividend of 10 per cent. for the year on the preference and 4 per cent. on the ordinary shares. The receipts had exceeded those of the previous year by £4,571; but the insurrection in Cuba had brought a vast amount of traffic over their wires. The ordinary expenses for working the traffic had been £238 more but there had been exceptional expenses amounting to £1,953, of which, however, £1,660 was attributable to the damage done to the Bilbao cable in 1894. In November of that year a steamer fouled their cable outside Bilbao. They brought an action against the owner of the vessel, but they failed. Still, one good thing had arisen out of the action so far as the future of all submarine telegraph companies was concerned. It came out during the trial that the ship which fouled their cable got its anchor entangled with two cables, one of them probably an abandoned cable of the Spanish Government. Both cables were dragged up to the surface, but the lighter of the two got disengaged from the anchor and disappeared, while with the other, which the Company claimed as theirs, nothing could be done, so it was severed. The important part of the judgment was in the following passage: 'If we were satisfied that the cable belonging to the plaintiffs had been cut, we should be of opinion that the captain had done that which he was not entitled to do, and that the defendants were responsible for the injury so caused, but we are not satisfied from the evidence that the cable of the plaintiffs was cut." That, he assumed, was the whole point on which they lost their case. He supposed it would be possible for hundreds of ships to anchor and never drag up two cables again, and he assumed that if in the future a ship fouled a cable, and those in charge of the vessel deliberately severed the line, the owner of the ship would be liable. A short time since a small ship fouled the Company's cable outside Falmouth. The captain on finding what had happened slipped all his gear and ran into port. He afterwards asked the Company to pay the damages, which they did, as he had taken the right course.

Mr. John D. Pender seconded the motion.

In reply to **Mr. Cochrane**, the **Chairman** said the returns for January and February had been extremely favourable, but with regard to Cuba, when there was an insurrection in a country trade must necessarily suffer. On the other hand it did not follow that the full force of that would be felt on this side, because the Spanish traded very largely with the United States, where a large proportion of these bad times would be experienced. He should have stated that they had placed £5,000 to the reserve, thus bringing it up to £28,000.

The report was then adopted.

At an extraordinary meeting subsequently held. Clauses 90 and 91 of the articles of association concerning the directorate was amended, the director to retire in the future being the one who has been longest in office.

BELL'S ASBESTOS COMPANY, LIMITED.

The eighth ordinary general meeting of this Company was held last week at the Cannon-street Hotel, E.C., Mr. Henry Heywood presiding.

The **Chairman**, in moving the adoption of the report, said that at the date of their last meeting their business at Southwark-street was increasing month by month and the demand for crude asbestos at the mines was good. Everything, in fact, pointed at the time to a satisfactory result at the end of their financial year. It was, therefore, with the greatest disappointment that the directors had to present a statement showing so great a diminution in the profit on the past year's trading. For some reason, the Johns Manufacturing Company, of New York, had refused to take deliveries of crude material which they had purchased of this Company, but he could not say for what reason. They would naturally understand that if, after making contracts extending over a considerable period of time and having mined and prepared the material, deliveries were not accepted serious loss must result. The managing director had proceeded to New York for the purpose of making some arrangement but his visit ended in failure, and there was no alternative for them but to take legal proceedings against the Johns Manufacturing Company. The business done by the Company during the year in Southwark-street had been, on the whole, perfectly satisfactory, and had increased during the year. Competition had been very severe, however, and prices had not been maintained.

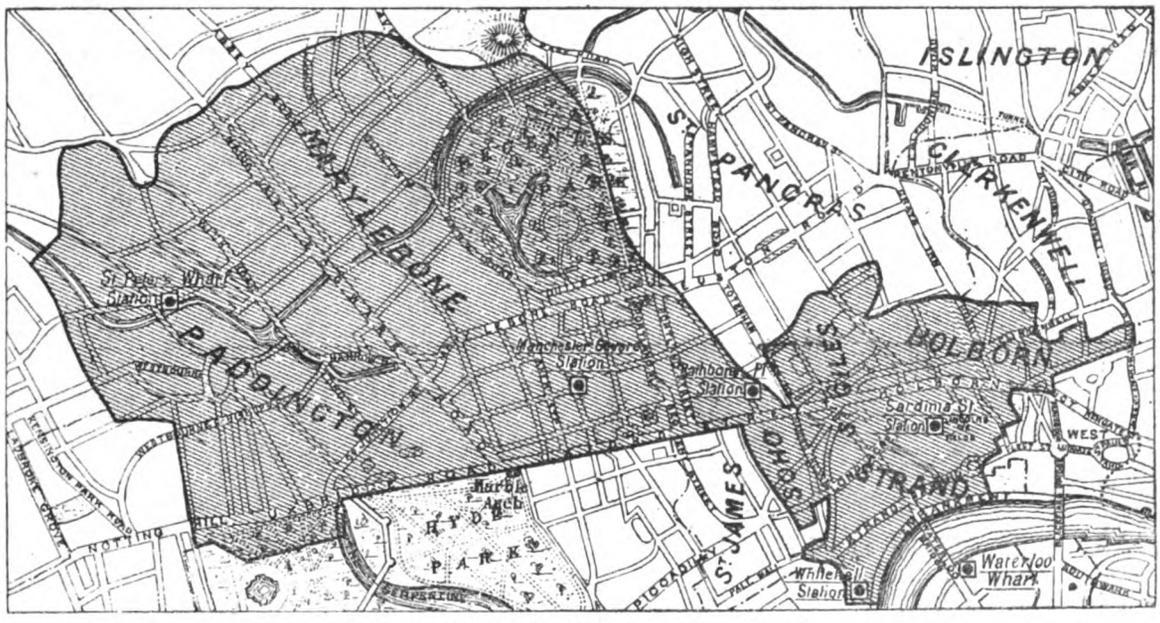
Mr. A. J. Burnett seconded the motion.

In reply to questions, the **Chairman** repeated that he did not know the reason why the Johns Manufacturing Company had refused to take deliveries. They stated that the Company were rather late in tendering the materials which had been bought, but this was denied.

The motion was adopted, and a dividend at the rate of 3 per cent. per annum was declared.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

Report of directors (with abstract of accounts) to be presented to the shareholders at the ordinary general meeting to be held at Winchester House, Old Broad-street, E.C., on Tuesday, March 31, at 12 noon.



Metropolitan Electric Supply Company.—Area of Supply.

The capital expenditure, which at the end of 1894 amounted to £628,931. 7s. 1d., has now reached a total of £675,484. 3s., having increased during the year by the sum of £46,552. 15s. 11d. As in the year 1894, this increase is caused by the development of the Company's operations, and principally consists of the cost of mains, transformers, and meters for the purpose of supplying consumers. In order to meet the growing demand for current it has been found necessary to push forward with extensions both of building and plant at the Sardinia-street and Amberley-road stations, and when these extensions are fully equipped they will provide for a considerable increase of business. A serious fire occurred at the Sardinia-street station on June 24, 1895, resulting in the complete destruction of the dynamo-room and contents, and damage to the station generally, but, owing to the system of trunk mains and to the assistance promptly rendered by the City of London and the London Electric Supply Companies, the inconvenience to the Company's customers was reduced to a minimum. The directors anticipate that the amounts received from the insurance companies will be sufficient to provide for the reinstatement of the buildings and plant, but as the permanent arrangements are not completed the accounts relating to the fire cannot yet be closed, and they appear in the balance-sheet for the present as an item in suspense. The gross revenue for the year amounted to £106,447. 8s. 9d., against £85,345. 18s. 7d. in 1894, being an increase of £21,101. 10s. 2d., as compared with the increase of £16,150 14s. 3d. in 1894, which the directors consider satisfactory. The balance to the credit of the revenue account, before providing for depreciation, is £39,154. 0s. 7d. The directors have set aside £12,000 as an addition to the depreciation fund, carrying to the credit of the net revenue account (No. V.) the sum of £27,154. 0s. 7d., which, with the balance brought forward from last account and other receipts, makes a total of £28,961. 0s. 8d. After deducting debenture interest and other charges, there appears a balance of £22,082. 4s. 4d., of which the directors have appropriated a further sum of

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£1,000 in reduction of the preliminary expenses account, which is now diminished to £1,052. 10s. 4d. An interim dividend of 3s. per share on the ordinary share capital was paid on November 13, 1895, amounting to £7,485, and the directors recommend that a further dividend of 5s. per share be now paid, making a total dividend of 8s. per share for the year, or 4 per cent. on the capital. This will absorb a further sum of £12,475 and leave a balance of £1,122. 4s. 4d. to be carried forward to the next account. The number of 8-c.p. lamps supplied by the Company increased during the year 1895 from 209,000 to 260,000. The present number of lamps connected is 272,000, and the applications show no signs of decrease. A report from the Company's chief engineer is appended, showing that the satisfactory condition of the stations, machinery, and plant has been maintained. In accordance with the articles of association, the following directors—viz., Sir John Pender, G.C.M.G., M.P., Admiral of the Fleet Lord John Hay, G.C.B., and Joseph Charles Parkinson, Esq.—retire from the Board, and are eligible for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and are eligible for re-election.

Report of Chief Engineer.—I have pleasure in certifying that the Company's stations, machinery, and plant are being maintained in an efficient condition and have worked satisfactorily up to the present date.—FRANK BAILEY.

REVENUE ACCOUNT FOR YEAR DEC. 31, 1895.

Dr.		£ s. d.
Generation of Electricity.		
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£26,376 9 1	
Oil, waste, water, and engine room stores	3,749 2 7	
Salaries of engineers, superintendents, and officers	2,408 8 6	
Wages and allowances at generating stations	6,525 2 10	
Repairs and maintenance as follows: buildings, £838. 9s. 2d.; engines and boilers, £5,575. 0s. 5d.; dynamos and exciters, transformers, motors, etc., £968. 0s. 2d.; other machinery, instruments, and tools, £1,220. 3s. 5d.; accumulators and accessories, £1. 13s. 11d.	8 603 7 1	
Purchase of current	4,874 4 10	
		52,536 14 11
Distribution of Electricity.		
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	91 8 10	
Repairs, maintenance, and renewals of transformers, meters, and other apparatus on consumers' premises	521 11 8	
Royalties	12 10 0	
		625 10 6
Rents, Rates, and Taxes.		
Rents payable and rates and taxes		3,141 14 0
Management Expenses.		
Directors' remuneration	2,175 0 0	
Salaries of management, secretary, engineers, accountants, clerks, and messengers	3,681 4 9	
Wages of meter readers and wiring inspectors	422 17 10	
Stationery and printing	528 0 9	
General establishment charges	2,003 3 9	
Auditors: Board of Trade, £86; Company's auditors, £157. 10s.	243 10 0	
		9,053 17 1
Law and Parliamentary Charges.		
Law expenses	264 14 6	
Parliamentary charges	1 273 6 7	
		1,538 1 1
Special Charges		
Insurances	393 16 0	
Expenses of surplus properties after allowing for rents received	3 14 7	
		397 10 7
Depreciation Fund.		
Depreciation in buildings, plant, machinery, &c.		12,000 0 0
Total expenditure		79,293 8 2
Balance carried to net revenue		27,154 0 7
		£106,447 8 9

Cr.	£ s. d.
Sale of current, £99,593. 16s. 7d.; less bad and doubtful debts, £800	98,793 16 7
Rental of meters and other apparatus on consumers' premises	7,446 5 1
	£106,240 1 8
Rents receivable	108 0 0
Special items—net proceeds of work done for and goods supplied to sundry consumers	99 7 1
	£106,447 8 9

GENERAL BALANCE-SHEET, DEC. 31, 1895.

Dr.	£ s. d.
Capital account—amount received	686,731 0 3
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	23,923 14 5
Sundry creditors on open accounts	4,819 12 4
Suspense account—Sardinia-street fire	2,789 0 3
Depreciation fund	27,064 9 11
Net revenue account—balance at credit thereof	13,597 4 4
	£758,925 1 6

Cr.	£ s. d.
Capital account—amount expended for works	675,484 3 0
Stores on hand—coal, £382. 4s. 3d; oils, waste, etc., £417. 1s. 9d.; general, £7,169. 1s. 1d.	7,968 7 1
Sundry debtors for amounts paid on account of contracts in course of completion	2,055 12 9
Preliminary expenses, £2,052. 10s. 4d.; less charged to net revenue account, £1,000	1,052 10 4
Sundry debtors for current supplied	45,186 0 3
Other debtors	2,302 2 2
Deposits (provisional orders, vestries, etc)	580 0 0
Depreciation fund, investment account	18 990 3 6
Cash at bankers on current account	5,306 2 5
	£758,925 1 6

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: the Right Hon. Lord Rathmore, LL.D. (chairman); J. B. Braithwaite, jun. (deputy-chairman); W. C. Braithwaite; Emile Garcke; Frederick W. Reynolds; Aymor H. Sanderson; Francis E Savory; R. Percy Sellon; B. H. van Tromp. Engineer and manager, A. J. Lawson, M.I.E.E. Secretary, H. Renwick.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the second ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., at 2 p.m. on Monday, April 13, 1896:

The capital expended during the year on the London stations amounted to £92,151. 10s. 9d.; the investments in shares and debentures of, and the sum advanced to, associated companies amounted to £73,396. 5s. 10d.—total, £165,547. 16s. 7d. This expenditure has been met by instalments falling due on ordinary shares and by the issue of 10,000 6 per cent. preference shares at par, mentioned in last year's report, which were applied for several times over, and now stand at a substantial premium. The balance to credit of revenue account for the past year, after payment of proportion of rents, rates, taxes, and general establishment charges, amounts to £2,714. 7s. 9d., to which must be added £332. 5s. 10d., brought forward from 1894 account, making a total of £3,046. 13s. 7d. Out of this sum an interim dividend for the half-year ending June 30 1895, at the rate of 6 per cent. per annum on the preference shares, was paid on July 15 last, and the directors recommend that a further dividend to December 31, 1895, at the same rate be paid upon the preference capital. This will leave a balance of £1,208. 19s. 1d. to be carried forward to next year's account. In the St. Luke and Clerkenwell districts the cables required for the compulsory streets have been drawn in and the transformer sub-stations have been constructed, but, owing to a strike of contractor's workmen, much delay has taken place in the completion of the generating station. Applications have nevertheless been received for the equivalent of 7,000 8-c.p. lamps, of which 5,700 are now connected to the Company's mains, and the directors anticipate that there will be a sufficient number of lamps applied for by the time the station is completed to ensure a profit being earned from the commencement of working the plant. In the Wandsworth district the Company's operations have been materially retarded, owing to objections having been taken by the local authority to the construction of transformer boxes in the streets. All questions have now, however, been satisfactorily arranged, and the generating station on the Wandle will soon be completed. The conduits for cables have been laid throughout the district, cables are being drawn in, and it is expected that about September next current will be available, along the route of the Company's mains, for all consumers who may then have applied for connection. In the St. Olave district, to which reference was made in last year's report, the provisional order was granted by the Board of Trade; owing, however, to the dissolution of Parliament, it was not confirmed last session. It will come up for confirmation in the present session. The Company has also applied to the Board of Trade for a provisional order for other areas in South London, and has received the consent of the Camberwell Vestry to the granting of an order for the district within its jurisdiction. The Company will be in a position to supply the parishes of St. Olave, St. George-the-Martyr, and Camberwell from one generating station. During the past year the Bournemouth Company's station has been completely remodelled and enlarged, and additional plant and mains have been laid. That station has now plant capacity for 27,500 8-c.p. lamps, and the equivalent of 21,000 8-c.p. lamps connected. The work of laying mains and equipping the Dover Company's station was completed last year, and an uninterrupted supply of current has been given since April, 1895. Referring to the plant supplied by the Brush Electrical Engineering Company, the Dover Company's directors in their report state: "In October last,

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exhaustive tests were made by Profs. A. B. W. Kennedy and Silvanus Thompson of the whole of the machinery in the station, with gratifying results, the efficiency of the plant being found to be very satisfactory." The professors in concluding a lengthy report state: "On the whole matter of the working of the boilers, and of the running of the plant in the station, it gives us pleasure to say generally, in conclusion, that as to output, efficiency, and economy, as well as in respect to general construction, the results are very satisfactory, and are substantially in accordance with the conditions of the specifications." The contract for street-lighting has been increased, and the equivalent of 4,557 8-c.p. lamps has already been connected to the Company's mains. The Richmond station, in which this Company obtained the controlling interest in April, 1895, has yielded, with an equivalent of 5,486 8-c.p. lamps connected at December 31 last (being an increase of 1,746 8 c.p lights within the year), a profit of £230. 2s. 1d. upon the 12 months' running, as against a loss of £978. 19s. 8d. in the previous year. Additional mains have lately been laid in order to reach new consumers, and further extensions are now under consideration. Mr. A. N. Denny, owing to unavoidable absence from England, has resigned his seat at the Board, and the directors have elected Mr Emile Garcke to fill the vacancy thus created. The retiring directors are Mr. J. B. Braithwaite, jun, and Mr. A. H. Sanderson, who are eligible for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re-election.

BALANCE-SHEET, DEC. 31, 1895.

Liabilities.			£	s.	d.
Capital authorised			800,000	0	0
Capital issued—					
22,475 ordinary shares at £10 fully paid			224,750	0	0
10,000 preference shares at £10	£100,000	0 0			
Less call due March 31, 1896	20,000	0 0			
	80,000	0 0			
Add calls paid in advance	5,734	0 0			
	85,734	0 0			
Less September and December calls unpaid	8,566	0 0			
			77,168	0	0
			301 918	0	0
Loans against security			34,000	0	0
Sundry creditors			12,260	1	11
Net revenue account—balance forward from last account	332	5 10			
Profit for the year, as per revenue account	2,714	7 9			
	3,046	13 7			
Less interim dividend paid on 10,000 6 per cent. preference shares from due dates of payment to June 30, 1895, less income tax	387	14 6			
			2,658	19	1
			£350,837	1	0

Assets.	£	s.	d.
Capital appropriated to the County of London (North) electric lighting order	75,911	0	8
Capital appropriated to Wandsworth electric lighting order	40,358	3	1
Lands, buildings, etc.	9,683	0	5
Preliminary expenses, £18,478. 4s. 3d.; less premium on second issue of ordinary shares, £618. 15s.	17.859	9	3
Investments in quoted securities at cost	21,646	4	7
Investments in and advances to associated electricity supply companies—shares at cost, £68,847. 8s.; and mortgages, debentures, and bills, £77,488. 15s. 9d.	146,336	3	9
Payments on account of contracts in hand	20,796	0	0
Provisional orders secured at cost	974	10	11
Pending applications for provisional orders at cost	461	19	3
Head office, furniture, and books, £1,217. 12s. 7d.; less amount written off, £60. 17s. 6d.	1,156	15	1
Sundry debtors	4,462	3	10
Cash at bankers and in hand	11,191	10	2
	£350,837	1	0

REVENUE ACCOUNT, 12 MONTHS TO DEC. 31, 1895.

Dr.	£	s.	d.
Proportion of directors' remuneration, salaries and wages, rents, rates and taxes, and insurance	2,000	9	4
Printing, stationery, and postage	166	9	9
Travelling expenses and sundry charges	533	8	8
Auditors' fees	75	0	0
Canterbury Electricity Supply Company, Limited—balance of preliminary expenses written off	85	5	0
Depreciation account—amount written off office furniture	60	17	6
Balance carried to net revenue account	2,714	7	9
	£5,635	18	0

Cr.	£	s.	d.
Gross profits derived from interest on investments, rents, discounts, and administration of associated companies	4,317	6	11
Transfer fees	40	12	6
Profits on investments realised	694	10	4
Balance from revenue account	583	8	3
	£5,635	18	0

SCARBOROUGH ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: G. Alderson-Smith, Esq. (chairman); John Dale, Esq.; John Woodall Woodall, Esq.; George Lord Beeforth, Esq; John Bell Simpson, Esq.; the Hon. Charles A. Parsons; Gilbert Wilkinson, Esq.; John Edward Ellis, Esq, M.P.; A. A. Campbell Swinton, Esq. (managing director). Mr. John Hall, secretary. Mr. G. S. Peck, resident engineer.

Report of directors, revenue account, and balance-sheet for the year ended December 31, 1895:

During the past year the Company has continued to make satisfactory progress. New customers to the number of 52, and the equivalent of 2,285 8-c.p. additional lamps, have been connected to the Company's mains, making a total of 235 customers and 12,788 equivalent 8-c.p. lamps connected to the present time. Since the date of the last report 571 yards of additional mains have been laid, making, with what previously existed, a total of 13,263 yards. The capacity of the mains and the number and capacity of the transformers have also been increased. To meet the increased demand, an additional boiler and two additional sets of engines, dynamo, and condenser, one set of 150 h.p. and one of 100 h.p. have been obtained, and are now in satisfactory operation. During the past year electric energy to the amount of 141,101 Board of Trade units has been supplied to customers at a gross revenue, including meter rent, of £3,613. 19s. 5d. Deducting from this the expenses, there remains a balance of £937. 9s. 8½d., which is more than twice the profit made in 1894. Adding the balance of £418. 12s. 3d. carried forward from the previous year, there is a sum of £1,356. 1s. 11½d. available for distribution. The directors recommend that this should be applied (1) in paying a dividend of 2½ per cent., which will absorb £772. 13s.; (2) in writing off the sum of £304. 16s. 0½d. from the preliminary expenses, leaving a balance of £278. 12s. 11d. to be carried forward. Mr. J. E. Ellis and Mr. Gilbert Wilkinson retire by rotation, but are still eligible, and offer themselves for re election as directors. The auditor, Mr. C. E. Bradley, C.A., also offers himself for re election.

BALANCE-SHEET, DEC. 31, 1895.

Liabilities.			£	s.	d.
Capital: nominal—5,000 at £10 each			50,000	0	0
Subscribed—3,434 £9 called up			30,906	0	0
Bankers			546	13	2
Sundry creditors			643	3	4
			32,095	16	6
Revenue account—Balance for year ending December 31, 1894, as per statement	£418	12 3			
Balance for year ending December 31, 1895, as per statement	937	9 8			
	1,356	1 11			
Less amount written off preliminary formation and management expenses *per contra*	304	16 0			
			1,051	5	11
			£33,147	2	5

Assets.			£	s.	d.
Capital expenditure—amount expended for land, buildings, machinery, mains, transformers, meters, electrical instruments, etc., to date of last statement			25,327	13	10½
Additional expenditure during year			5,300	1	3
			30,627	15	1½
Provisional order			525	0	0
Formation and preliminary management expenses (less amount received for current, rent of meters, bank interest, etc., up to Dec, 31, 1894), as per last statement	£648	9 0			
Expended since	6	7 0			
	654	16 0			
Less amount written off per revenue account	304	16 0			
			350	0	0
Office furniture and fittings, stock of stationery, books, etc			155	8	8½
Stock of lamps on sale			1	13	4
Stock of stores and repairing materials			102	5	3
Sundry debtors, less provision for discount	1,401	15 6			
Less provision for bad debts	16	15 6			
			1,385	0	0
			£33,147	2	5

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REVENUE ACCOUNT FOR THE YEAR ENDED DEC. 31, 1895.

Dr.	£ s. d.	£ s. d.
Expenses of generation and distribution of electricity and expenses of management as follows—		
Wages, salaries, rent, rates, etc. ...	£838 18 11½	
Stores, fuel, lighting, etc.	1,151 0 0	
Repairs and renewals	354 13 4½	
Stationery, office, and general expenses	110 7 10½	
		2,455 0 2½
Bank and other interest	60 17 0	
Provision for bad debts ...	16 15 6¾	
		77 12 6¾
		2,532 12 9¼
Balance for year carried down		937 9 8½
		£3,470 2 5¾
Amount written off formation and preliminary management expenses this year		£304 16 0½
Balance at credit at date...		1 051 5 11
		£1,356 1 11½

Cr.	£ s. d.
Electric energy, etc., supplied, less discounts ...	3,367 12 6¾
Meter rents... ...	98 17 11
Sundries	3 12 0
	£3,470 2 5¾
Balance from 1894 revenue account brought forward	£418 12 3
„ 1895 „ „ „ down...	937 9 8½
	£1,356 1 11½

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Private consumers by meter (B. T. units)	135,177½
Quantity used on works (B. T. units)	5,924
Total quantity accounted for (B.T. units) ...	141,101½
Total maximum supply demanded (kilowatts) ...	215

The fourth annual meeting of this Company was held at Scarborough last week, Mr. J. W. Woodall presiding.

The **Chairman** in moving the adoption of the report, expressed sincere regret that, owing to a rather serious illness, the chairman of the Company, Mr. G. A. Smith, was unable to be present. Proceeding to refer to the report, the Chairman said that that statement represented the first whole year's working, because during 1894 they had hardly settled down to the work and conditions of supply. The policy pursued by the members of the Board had been, and would be in the future, to give as good a supply as possible to the consumers whilst attempting to carry out such economy as would eventually conduce to the proper working of the concern. Owing, as Mr. Swinton, the managing director, would tell them, to the expense incurred by the great amount of current that was required at a late period of the autumn, their receipts per lamp did not show a very large average. But, on the other hand, the cost of production per unit would compare very favourably indeed with that of other companies which were far better situated for a continual demand. A moderate increase in the winter supply and a further demand would show better results, and there was every reason to hope for such a demand in the future. The result of the working for the year, according to the balance-sheet, would allow a dividend to be paid at the rate of 2½ per cent. on the paid-up capital, after writing off sundry expenses connected with the formation of the Company. The result of the working, after bringing forward £418 12s 3d. from the revenue account of the previous year, showed a balance to the credit of the revenue to the amount of £937. 9s. 8½d., which made a total of £1,356. 1s. 11½d. available for distribution. Of this sum they were reminded by the directors that £304 should be written off from the preliminary expenses, which would leave a sum of £350. There was another item which would also have to be reduced regularly, and that was the provisional order of £525. That would have to be written down, and would have to be provided for in the reserve fund. Then they proposed to pay out of the £1,356, less the £304, £772 less income tax on the shares, and to carry forward an amount of a little more than £278. This would, he thought, be all that they could do that year. They were bound to look forward and provide a year's income for the Company for the future. Then he might say that as certain of their directors were residents in Newcastle, and as the Newcastle shareholders had a very large interest in the concern, it was thought that they should be remunerated and their expenses paid for coming over to Scarborough, because it involved a whole day, and very often it meant their remaining overnight. Therefore a motion would be made for a certain sum to be voted in order to meet the necessary expenses incurred in this way. In conclusion, Mr Woodall said he begged to move the adoption of the report and balance sheet, and that a dividend of 2½ per cent. be declared upon the amount standing to the credit of the shareholders.

Mr. A. A. Campbell Swinton seconded the motion, saying that the progress of the Company, though slow, was very satisfactory. The people in Scarborough consumed a very small amount of electricity per lamp. If they took the consumption and units and divided it by the number of lamps they would only get 11 units per lamp per annum. Coupled with that, they supplied current at a very low rate, much lower, in fact, than was the case in some places, and they only got a little under 5s. 6d. per lamp. This was the lowest amount, he might say, received in the case of any company in Great Britain, and, of course, when they got a very low revenue they could not expect a very large margin of profit. In 1891 there were 6,378 additional lamps. The increase last year had not been anything like that. It was not to be expected, because the previous year was really the first year of working. He thought if they went on adding at the rate of 2,285 lamps per annum they would do very well. They were adding mains at the present moment along Victoria-road, and, of course, all these mains were very expensive, and in taking into account the cost of these mains, wires, and cables, it should also be taken into account that everything had to be done upon a scale that would enable them to deal with a very much larger number of lamps than were actually connected. They did not put any larger cables into the pipes than they really wanted, but the pipes themselves were sufficiently large to take double the number of lamps that they provided at the time. Unless they did this a great deal of unnecessary work would be caused by their having constantly to take up the mains again.

After some conversation, in the course of which **Mr. Sinfield** suggested that there ought to be a higher dividend, the report and balance-sheet were adopted and the retiring directors re-elected.

Mr. L. P. Edwards proposed, and **Mr. F. Bright** seconded, that the sum of £100 be voted for the purpose of remuneration to those directors coming to Scarborough from a distance for the purposes of the business of the Company, and the motion was carried without opposition.

TRAMWAYS ELECTRICAL TRACTION COMPANY, LIMITED.

The report of this Company for the year ended February 29, 1896, states that the directors have entered into negotiations with the French Thomson-Houston Company for the sale of the Company's interest in the Rouen Tramways Company. An agreement was come to, the French Thomson-Houston Company taking over all the liabilities, repaying the cash advances made on account of the Rouen Tramways Company, with interest at 6 per cent., and acquiring for £100,000 the 7,094 ordinary and 48 *jouissance* shares in the Rouen Company owned by this Company, and these sums will be paid over in cash on April 10 next. The net result of the sale is that there is a balance at credit of profit and loss account of £81,215, and it is proposed to pay a dividend of £5 per share on 15,000 ordinary shares of £1. 10s. each (fully paid), leaving a balance to be carried forward of £2,090. The directors propose to wind up the Company, with the view of returning the paid-up capital—viz., £5 per share on the preference and £1. 10s. per share on the ordinary shares.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Derby.—The Corporation want tenders by April 13 for low-tension cables and junction boxes. Particulars will be found in our advertisement columns.

Prague (Austria).—Tenders are wanted by June 1 for an electric lighting central station for the city of Prague. Application should be made to the Stadrath, Prague.

Copenhagen.—Tenders are required for the supply to the Danish State Railways of eight tons of telegraph wire, a quantity of pine wood, 8,000 zincs for telegraph batteries, and 1,800 caps.

Paris.—On April 9 there will be a limited competition at the Hotel de Ville for the supply of eight standards for the electric lighting of the Quai de Jemmapes and the Quai de Valmy.

Elberfeld.—Tenders are wanted by April 20 for the supply of four engines and dynamos and 174 lamps, conductors, etc , for the Prussian State Railways. Address, die Königliche Eisenbahn-Direktion, Elberfeld, Germany.

Vienna.—Tenders are wanted by April 15 for the supply of fastenings and tubes for an extension of the Vienna telephonic system. Particulars can be obtained from the Austrian Administration of Posts and Telegraphs, Section 13, Vienna.

Harrogate.—Tenders are wanted by April 7 for the electric lighting of the Prince of Wales Hotel. The installation is to be for about 400 lights, with engine and dynamo, and also an installation of telephones and electric bells. Particulars can be obtained from Mr. W. Leake, 30, Victoria-buildings, Manchester.

Brunn (Austria).—The Municipality desire offers for the construction and working of a central station for the supply of electric energy for lighting the town, for power, and. if required, for running a tramway. Tenders must be sent before March 31 to the Bürgermeister, Brünn, Austria, from whom particulars can be obtained.

Chiclana de la Frontera (Spain). - Tenders are wanted for the electric lighting of Chiclana de la Frontera, near Cadiz. The number of lamps required is 210 16 c.p , and the estimate is 15,000 pesetas (about £600) a year. The duration of the contract is 15 years, and tenders must be sent to the local authorities before April 6.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and main-

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tenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grange town, Yorkshire, to whom the plans, etc., must be sent by May 1.

Lima (Peru).—Tenders for the electric lighting of the city of Lima will be received up to June 1 next at the Peruvian Legation, 13, Comeragh-road, West Kensington, W., where applicants can obtain a memorandum explaining the local conditions. The tenders will be opened and considered by the Municipality of Lima, which reserves to itself the right of selecting that which is most approved or rejecting all if it thinks fit.

Shoreditch, E.—The Vestry require tenders for engines, electric generators, switchboards, pumps, steam and water mains, cast-iron work, motor transformers, and accumulators. Specifications, etc, can be obtained of the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, S W, on payment of £3. 3s, which will be returned on the receipt of a bona fide tender. Tenders, endorsed "Tender for Contract No. 4." to be sent in by 4 p.m. on April 14.

Bedford.—The Electric Light Committee invite tenders for the supply and erection of the following plant: (Section A) one 240-b h.p. double-acting compound enclosed engine, (B) one 150-unit alternator, with stationary armature. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. T. S Porter, clerk to the Urban Sanitary Authority, Town Hall, Bedford, on payment of a fee of 5s. for each section. Tenders sealed and marked "Electric Lighting, Section A or B," must be delivered to the clerk by April 4.

Bradford.—The Corporation invite tenders for the erection of a building required for the new electricity station at the junction of Valley-road and Lionel-street in the borough. Plans and specifications may be seen and bills of quantities obtained, free of charge, on application to Mr. Thomas Barker, A.M.I.C.E., architect, at his offices, 5, Bond-street, Bradford. An assurance must be given by each contractor that he pays to the workmen employed by him not less than the minimum standard rate of wages. Tenders, endorsed "Tender—Electricity Works," to be sent to Mr. W. T. McGowen, town clerk, Town Hall, Bradford, by April 8.

Chesterton (Cambs).—The Urban District Council are open to receive tenders for the public lighting of the district for seven years. The tenders shall be made in the three following modes—namely, (*a*) lighting the district from August 14 to May 15 (inclusive) in each year; (*b*) lighting the district throughout the whole year commencing May 15 next; (*c*) lighting the district for either of the above periods (1) with ordinary burners, (2) with incandescent burners, if the illuminant with which the tender be made be gas. All cleaning, lighting, and maintenance to be done by the contractors. Tenders to be sent to Mr. James Spearing, clerk, 15, Sydney-street, Cambridge, by March 31.

Cardiff.—The Corporation require tenders for the construction, supply, delivery, and fixing of two boilers of the dry-back marine or water-tube type, each to evaporate about 6,000lb. of water per hour, and one 250 to 300 kilowatt direct-driven steam alternator. Specifications may be obtained on application to Mr. W. Harpur, M.I.C.E, borough engineer, Town Hall, Cardiff. Sealed tenders, addressed to Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, and endorsed "Tender for Electricity Works," must be left at his office by April 6. A fee of £1 1s. will be charged for a copy of the specifications, which fee will be refunded on the return of the specifications, accompanied by a bona fide tender.

Egremont.—The Wallasey Urban District Council require tenders for the following requisites—viz.: (a) steam alternators, switchboard, and accessories; (b) high and low tension concentric cables; (c) transformers. Copies of the specifications may be obtained on application to the engineer, Mr. J H. Crowther, Gas and Water Works, Great Float, near Birkenhead. A charge of £2. 2s. will be made for copy of each specification, to be returned on receipt of a bona fide tender. Sealed tenders, on the form to be provided for the purpose, addressed to the chairman of the Gas and Water Committee, and endorsed "Tender for Steam Alternators, Switchboard, and Accessories," or any other contract, as the case may be, to be delivered at the office of Mr. W. Danger, clerk, Public Offices, Egremont, by 4 p.m. on April 6. Each contractor will be required to enter into a bond with approved sureties for the performance of contract.

Antrim.—The Commissioners for the Control of Lunatic Asylums will receive sealed tenders up to 10 a m. on May 1 for the supply and erection of an electrical installation at County Antrim Lunatic Asylum. The tender should be sent in a sealed envelope, endorsed outside "Tender for Electric Lighting, County Antrim Asylum," and addressed to the secretary, Board of Control, Custom House, Dublin, and should be accompanied by a separate sealed envelope, similarly addressed and endorsed, containing the detailed estimate. Forms of tenders, and copy of specification, which has been prepared by Mr. J. H. Greenhill, M I E E, will be issued on application to the office of the Board of Control of Lunatic Asylums, Dublin, on deposit of £3, which will be returned to all persons who have sent in bona fide tenders. Plans can be seen at the office of the architect, Mr. John Lanyon, Northern Bank-chambers, Royal-avenue, Belfast.

Manchester.—The Lancashire and Yorkshire Railway Company invite tenders for the supply of the following articles during 12 months ending April 30, 1897: copper rivets, washers, and tubing, signal and telegraph fittings, and signal, telegraph, and electric light wires. Further particulars and forms of tender may be obtained on application at the Stores Department, Osborne-street, Manchester, where parties are requested to call and examine the samples before tendering. The sample-room will be open for this purpose from 23rd inst. to April 2, between 10 a.m. and 4 p.m; Saturday, 10 a.m. to 12 noon. Contractors cannot be allowed to tender to their own patterns, nor can the company's patterns be sent away for inspection, all being sealed and exhibited at Osborne-street. Tenders, properly endorsed, and addressed to the Directors, must be lodged with Mr. C. W. Bayley, secretary, Hunt's Bank, Manchester, by 10 a.m. on April 6. Separate forms of tender will be provided for each contract; parties applying are therefore requested to state the particular contract for which they propose to submit tenders.

RESULTS OF TENDERS.

Durban (Natal).—The Corporation have received the following tenders for the electric lighting plant. Mr. J. Fletcher, borough engineer. Mr. W. H. Radford, C.E, Nottingham, consulting engineer:—

J. G. Statter and Co., 68, Victoria-street, London, S.W.	£17,901	0	0
Wigston Electrical and Engineering Company, Limited, London	17,360	0	0
British Thomson-Houston, Limited, Westminster, S.W.	20,057	3	0
Goddard, Massey, and Warner, Nottingham	23,926	0	0
Brush Electrical Engineering Company, London, E.C.	16,365	0	0
Siemens Bros. and Co., Limited, Woolwich	16,350	0	0
Crompton and Co., Limited, London, E.C.	15,001	16	0
Electric Construction Company, Limited, Wolverhampton (accepted subject to modifications)	15,007	0	0
For cables only.			
Telegraph Manufacturing Company, Limited, Helsby	6,114	0	0
India Rubber, Gutta Percha, and Telegraph Works, Limited, 106, Cannon-street, London, E.C.	5,442	14	0

BUSINESS NOTES.

Rand Central Electric Works, Limited.—Letters in respect of the second call of this Company have been posted.

Manchester.—The City Council have granted an advance in salary of £100 to Mr. C. H. Wordingham, engineer of the electric light department.

Fareham.—At a special meeting of the Urban Council, Mr. Blake, jun., was appointed manager at the electric light works, at a salary of £130 per annum.

Sunderland.—M. F. Tulloch has held the Local Government Board enquiry into the Town Council's application to borrow £16,000 for electric lighting extensions.

A Big Lamp.—It is stated that the Belvedere tower to be erected at the Empire of India and Ceylon Exhibitions will be illuminated by a lighthouse lamp of 4,000,000 c.p.

Worcester.—In consequence of the engineer's report, it has been decided to increase the charge for current for the Sewerage and Water Committees' motors from 1d. to 1½d. per unit.

Western and Brazilian Telegraph Company.—The receipts for the week ending March 20, after deducting 17 per cent. payable to the London Platino-Brazilian Telegraph Company, were £2,694.

Chelsea.—The Vestry have decided to offer no opposition to the Chelsea Electricity Supply Company, Limited, applying to the Board of Trade for a provisional order to light the western portion of the parish.

Notice of Removal.—Messrs. Bergtheil and Young, electrical engineers and contractors, of 13, Walbrook, London, are removing to larger and more commodious premises at 12, Camomile-street, Bishopsgate-street, E.C,

Lambeth.—The Electric Lighting Committee met on Wednesday last, and after a spirited debate they decided by a large majority to recommend the Vestry to accept the offer made by Mr. C. W. Sax for the provisional order.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending March 22 amounted to £1,149, as compared with £943 in the corresponding week of the previous year, being an increase of £206.

Silicon Electric Lamp Syndicate, Limited.—This Company has been registered, with a capital of £8,000 in £1 shares, to carry on the business of electric and other lamp manufacturers and the general business of an electric light company.

Doncaster.—The Doncaster and District Co-operative and Industrial Society's new premises in Station-road, of which the memorial stone has just been laid, will be lighted entirely by electricity. The dynamo-room is in the basement.

Electro-Metallurgical Company, Limited.—This Company has been registered, with a capital of £100 in £1 shares, to acquire, develop, turn to account, and deal with any inventions for the production of chrome or other metals by electrolysis.

Mevagissey (Cornwall).—The electric light company has held its first meeting, Mr. C. M. Grier presiding. Mr. Hedly, the engineer, stated that the street lights were now completed, and he saw nothing to hinder the success of the company.

Electrical Trades Union.—A smoking concert will take place at the Clerkenwell Town Hall, Rosebery-avenue, E.C, under the auspices of the London central branch, on Saturday, March 28, at 8 p.m. The chair will be taken by Bro. G. W. Montague.

Oriental Telephone and Electric Company, Limited.—The directors of this Company have resolved to recommend to the shareholders, subject to final audit of the accounts, a dividend for the year ended December 31 last of 5 per cent., free of income tax.

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Kharkoff (Russia).—The Municipality has requested French firms doing electric lighting work to forward, addressed Hotel de Ville, Kharkoff, prices and particulars of machinery, including engines and dynamos, as well as lamps, conductors, and fittings.

Electrical Installation Rules.—We have received from the Liverpool and London and Globe Insurance Company an advance copy of the 1896 edition of "Electrical Installation Rules," installations in conformity with which will be allowed by the company at current rates.

Electricity in the Colliery.—Electricity has been practically applied in the Marles colliery in the Pas-de-Calais, where electric locomotives are now in use. These weigh three tons each, and draw three cars, holding each 15 tons of coal, at the rate of 10 miles an hour. They replace 30 horses.

Rathmines (Dublin).—A special meeting of the Commissioners has been held to consider the question of electric tramway extension in the township. Resolutions were passed disapproving of the orders applied for by the Dublin United Tramways Company and the Rathmines, Dundrum, and Blackrock Tramways Company.

Islington.—At the Vestry meeting, the clerk said the Electric Lighting Committee had entered into arrangements with the County Fire Office for increasing very considerably the insurance of the electric light station. They asked the Vestry to refer to the Finance Committee for payment a sum of £171. 8s. 3d. This was agreed to.

Anglo-American Telegraph Company.—The directors of the Anglo-American Telegraph Company, Limited, have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending March 31 of 12s. per cent. on the ordinary stock and 24s. per cent. on the preferred stock, less tax.

City and South London Railway.—The returns for the week ended March 22 were £952, compared with £893 for the corresponding period of last year, being an increase of £59. The total receipts for the half-year terminating as above were £11 738, compared with £11,716 in the same period of the preceding year, being an increase of £22.

New Swindon.—At a meeting of the Urban Council the Electric Light Committee recommended that Mr. J. G. Aldridge, electrical engineer, be asked to attend and explain to the committee his former report upon the question of providing electric light in the town. The recommendation was adopted, and the name of Mr. Longland added to the committee in the place of Mr. D. E. Marsh, who has left the town.

London Electro-Plating and Refining Company, Limited.—This Company has been registered, with a capital of £1,000 in £1 shares, to acquire and carry on the business of electroplaters, electrotypers, enamellers, etc., carried on by A. V. Pittar and A. Soden at St. John's-passage, Clerkenwell, as the London Electro-Plating and Refining Company.

Bradford.—Some details have been issued showing the extent to which it is proposed to carry the electric lighting system when the new station has been laid down. The area at present to be covered by the main supply wires will include Manningham and Girlington and Lidget Green on one side, and on the other side Horton, Bowling, and Undercliffe.

Eastern Telegraph Company.—The Company announce the payment on April 14 next of interest of 3s. per share, less income tax, being at the rate of 6 per cent per annum on the preference shares of the Company for the quarter ending March 31, and the usual interim dividend of 2s. 6d. per share on ordinary shares in respect of profits for the quarter ended December 31 last.

Paddington.—A letter was read from the Board of Trade forwarding copy of a letter which they had addressed to the undertakers under the Paddington electric lighting order, with regulations for securing the safety of the public and for ensuing a proper and sufficient supply of electrical energy. The communication was sent to the Electric Lighting Committee of the Vestry.

Institution of Engineers and Shipbuilders.—At the sixth general meeting of the Institution of Engineers and Shipbuilders in Scotland, a discussion took place on Mr. John Inglis's paper on "Rates of Speed and Rates of Freight," and a new paper was contributed by Mr. J. G. Stewart, B.Sc., on "The Manufacture of Welded Iron and Steel Pipes." Mr. William Beardmore contributed a paper on "Nickel Steel."

Paisley.—It has been decided by the Town Council in committee to acquire the necessary plant for providing electric light within a radius of half a mile from the old prison buildings in the centre of the town, where it is proposed to place the workings. This means that all the public buildings will be able to adopt the electric light, and it is expected that most of the principal shopkeepers will also take advantage of it.

Swadlincote.—At the meeting of the Urban Council the Highways, Buildings, and Sewerage Committee reported that Mrs. Woodward has applied for permission to lay an electric cable under the road from her works through Coppice Side to boundary of the district at the Girder Bridge. The matter had been adjourned for further particulars. In the estimate for the next six months £100 is included for electric lighting at Stanton.

Dover.—Mr A. G. Grossmann has finished the installation of the electric light in his studio, which includes a new triple-arc portable lamp, which he has invented specially for taking photographs at night. The lamp is movable on castors, and is attached to a flexible tube which carries the current from the main. The special arrangement, the patent of which is protected by provisional license, adjusts the carbon points by a spring.

The Telephone in Royal Residences.—Telephonic communication has recently been established between Marlborough House and the general London system, and also between Buckingham Palace and other parts of the Metropolis. In the case of Buckingham Palace, communication with Windsor is now in existence, and members of the Royal household in London and at the Castle respectively can converse with the greatest ease.

Torquay.—The gas company will probably again reduce the price of gas, as a counter-move to the proposal to introduce electric light. "As one much interested in the town," the chairman of the company "trusts the authorities will pause and consider very seriously before embarking further on such a heavy burden to the already heavy debt with such a doubtful return, and with the knowledge, it would seem, that public opinion is against it."

County of London and Brush Provincial Electric Lighting Company.—The directors have decided to recommend payment of a dividend for the six months ended December 31 last at the rate of 6 per cent. per annum from the due dates of payment, less income tax, on the preference shares of the Company, subject to confirmation at the general meeting to be held on April 13. The transfer books and register of members will be closed from April 1 to April 13 inclusive.

Brighton.—During the past week representatives from the Croydon and Ripon Corporations and from the Mile End Vestry have been inspecting the system of street-lighting which has been adopted here, and looking over the generating station, where the new works and extensions are making good progress. It is stated that 38 members of the Association of Municipal Electrical Engineers have definitely arranged to visit Brighton shortly on a similar errand.

Montreal (Canada).—The Lachine Rapids Hydraulic and Land Company, Limited, of Montreal, Canada, have placed an order with Mr. Frederic Nell, of 97, Queen Victoria-street, E.C., for 66 54in.-cylinder gate "Victor" turbines together with all the gearing, shafting, etc., for transmitting the power to the electric generators. The power will be transmitted electrically into the city for street railway and lighting purposes. This is about the largest contract for turbines ever placed.

Leeds.—The first section of the Lamp Committee of the City Council has made a tour of the Mill Hill, West, North-West, and Headingly Wards, and decided to recommend the General Committee to sanction the erection of 16 additional lamps at various points in the districts indicated, chiefly in the courts and alleys. It transpired that no less than 600 new lamps have been erected in the city during the last 12 months, and that Leeds is now illuminated by no fewer than 11,000 public lamps.

Holywood.—A meeting of the inhabitants of the district has been held to consider the feasibility of constructing an electric tramway from Belmont to Holywood along the old Knocknagoney road. Mr. Ryan, M.I.C.E., said the line could be worked by electric traction for about 4d. per car mile, while horse traction costs about 8d. per car mile. Mr. Nance had promised every facility for connecting with the Belfast tramway. A resolution was passed heartily approving the scheme. The overhead system seems to be most in favour.

Blackpool.—It has been suggested that as three-fourths of the electric lighting plant is now lying idle for 20 hours out of each 24, some use should be made of the plant in the way of providing current for the tramway service. Mr. Ferranti has undertaken to enquire if some arrangement of accumulating and converting from high to low pressure could not be devised, so that the machinery not required for electric lighting purposes in the daytime could not only run the tramway system, but store sufficient current as would be necessary to work the cars at night.

Bolton.—At a meeting of the Gas and Electricity Committee the electrical engineer was requested to furnish an estimate of the cost of laying electric mains in Bowker's-row, and a list of the probable consumers. It was reported that in the electricity department the amount received for the month was £628, as against £258 in the corresponding month last year, making a total for the past 12 months of £2,583. There were now 115 connected consumers with an equivalent of 9,378 lamps of 8 c.p., and six consumers nearly ready for connection, making an additional 360 8-c p. lamps.

The London Commissioners of Sewers.—Notice has been given by the Commissioners that they have appointed an electrical inspector, and have provided a well-equipped laboratory to enable him to carry out the duties required under the City of London electric lighting orders. Persons wishing to have their electricity meters tested, or desiring to know the pressure of the electric supply, or otherwise requiring the services of the electrical inspector, as prescribed by the above-mentioned orders, should apply to that officer at the electrical laboratory of the Commissioners in the Wool Exchange, Basinghall-street, E.C.

Llandrindod Wells.—At the meeting of the Urban Council Mr. Vaughan Vaughan, solicitor, Builth, representing Mr. Edward Davies, the electric light contractor, waited upon the Council and stated that Mr. Davies was very anxious to proceed with the work as quickly as possible, so as to get the electric light installed at the earliest possible moment. There would, however, be some details to go into, for which the clerk of the Council or a sub-committee would have to meet Mr. Davies. It was eventually agreed that the clerk should write to Mr. Davies and request him to fix a date for an interview for the discussion of details

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Telegraphic Communication Along the Coasts —At the annual meeting of the Royal National Lifeboat Fund, the Duke of York, who presided, made special reference to the electrical communication on the coast, and said that in the past year the system had been largely increased, and had already shown to all of what great use and importance it was. The Duke of Norfolk stated that it was the desire of the department he represented to do everything possible to extend that system. The statement that £40 000 was to be expended in the coming financial year to perfect these arrangements would, he felt sure, meet with general approval.

Kingston-on-Thames.—At a meeting of the Town Council Councillor Collings, in moving that a cheque for £100 be drawn in favour of Mr. A. H. Preece, the electrical consulting engineer, said the engagement with Mr. Preece would terminate as soon as the capital outlay to which the Corporation was now pledged in respect of the electric light was completed. Mr. Preece's services had been most useful to the Corporation, not the least valuable part of his work being his influence with Messrs Siemens, in getting them to make and lay an entirely new arc lighting cable free of cost to the Corporation. The cheque was ordered to be drawn.

Canterbury.—Mr. Robert Hammond, the electrical engineer consulted by the Town Council on the subject of an installation in the city, has attended a whole house committee meeting. Mr. Hammond's report was strongly in favour of the adoption of the undertaking by the Town Council. We learn that the majority of the members of the Council were favourably impressed with the scheme, and there is every prospect that it will be carried into effect. No definite expression of opinion has been recorded, but the Lighting Committee were directed to bring up recommendations on the subject in order that the matter may come before the Council in regular form at a future date.

Electric Tricycles.—When the present statutory restrictions in connection with self propelled vehicles are removed there will probably arise a demand for an accumulator suitable for use as a source of power for driving a tricycle. In view of this, the Epstein Company have been turning their attention to the subject and have produced cells which will give 10 to 12 watt-hours per pound weight. Assuming that about a quarter of a horse-power is required, this gives a weight of from 15lb. to 19lb. per hour run. The main point of the new cells, however, is stated to be not so much their weight as the very wide limits within which the rate of discharge can be varied. It remains to devise a suitable motor.

Appointments Vacant.—The Corporation of Morley require the services of a competent man to take the entire charge of the electric light installation of the town hall, including the engine, boiler, dynamo, and lamps throughout the building Applications, stating previous experience, age, and salary required, to be received by Mr. R Borrough Hopkins, town clerk Town Hall, Morley, not later than noon on 30th inst. All applications to be endorsed "Electric Lighting."—The Lighting and Electrical Committee of the Cardiff Corporation have decided to advertise for three competent engine-drivers, resident in the town, at a salary of 34s. per week; and also for a qualified fitter at 42s per week.

London Improvements.—Mr. H. T. Steward, Home Office inspector, has concluded his enquiry into the scheme prepared by the London County Council under the Housing of the Working Classes Act for clearing a large area in Clare Market declared insanitary by the medical officer of health. Mr. Wolton, engineer to the Metropolitan Electric Supply Company, was examined with regard to the effect that the carrying out of the scheme would have upon the mains of the company in the district. He stated that there would be a great loss of energy if the mains were altered or transferred, in addition to an enormous cost being entailed. There might also be considerable danger to life involved in any change.

London.—The Highways Committee of the London County Council have received an application from the National Telephone Company for the use of 144 square inches of sectional space in the Commercial-road subway, between the junction of Commercial and Whitechapel roads and the end of the subway. The committee recommend that the request be acceded to upon condition that all work in or about the subway in connection with the placing of the company's wires therein shall be carried out under the supervision of the Council's chief engineer and at the sole cost of the company, and that any damage that may be done in or about the subway in the execution of the work shall be made good by the company to his satisfaction.

Folkestone.—It appears that the Corporation are more than likely to dispose of the powers of their provisional order. The committee thrashed the matter well out, and a resolution was moved that the Corporation themselves carry out the electric light within the borough, at a cost not exceeding £20,000. To that there was an amendment moved that the Corporation be recommended to treat with a company or persons, on terms to be arranged, for the disposal of the powers. The amendment was carried, and on its being put as a substantive motion, 12 voted for it and 3 against. A long discussion took place at the meeting of the Council, but eventually the committee's recommendation was adopted, and the report was referred to a committee of the whole Corporation.

Aberdeen —At a meeting of the Mechanical Society, Mr. L. L Horne, electrical superintendent for the Great North of Scotland Railway Company, read a paper on "Small Electric Plant." Mr. A. Sproule, president of the society, occupied the chair. Mr. Horne, at the outset, dealt with the advantages of electric light in prisons, workshops, and theatres, remarking that, after all, the places that derived most benefit from the light were hotels and large country mansions. Turning to the relative advantages of different systems, he gave numerous particulars regarding the various methods of generating the current, making special reference to the vexed question of the advantage or disadvantage of the use of accumulators; and, in conclusion, dealt with the cost of installation. A discussion followed.

Belfast.—At a meeting of the Law and Improvement Committee the report of the sub-committee appointed to visit several English and Continental cities and towns to make investigations into the question of electric traction for tramcars was read by the town clerk. It was a lengthy document, and contained many valuable statements, but no action was taken in the matter. A meeting of the Council in committee was subsequently held under the presidency of the Lord Mayor. There was considerable discussion as to whether or not the report of the electric traction deputation should be read at the meeting, and finally a vote was taken on the subject, with the result that the proposal to read it was negatived. The town clerk was then requested to have the report printed and circulated. The report recommends the adoption of the overhead system.

Electric Lighting in the Strand District.—A Select Committee of the House of Commons, presided over by Sir James Kitson, has passed a Bill which confirms a provisional order granted by the Board of Trade to the Charing Cross and Strand Electricity Supply Corporation, Limited, authorising them to light with electricity the area of the Strand District Board of Works The Bill has been opposed by the Metropolitan Electric Supply Company, Limited, who already supply the Strand district, but it was put forward in evidence that, whilst the Metropolitan Electric Light Company used the high-tension current, the Charing Cross Company would supply the direct low-tension current, which would be a great advantage to all who required electricity for motive power. This Bill has now received the sanction of both Houses, having passed the House of Lords before the dissolution.

Peterborough.—The borough engineer (Mr. J. C. Gill) has submitted his statement of the annual cost of working, and the income to be derived, to a meeting of the Council; but consideration of the matter was postponed to a special meeting. Mr Gill estimates that the annual expenditure on private incandescent lighting would be £2,407 and on public arc lighting £721. He states that at the end of the 25 years—payments on account of loan having ceased—electric current will be produced at the cost of 2d. per unit When working at full load, and charging 6d. per unit for the current, the proposed plant will not only provide the amounts to be paid off annually for purchase, depreciation, and cost of working, but will in addition to that leave a margin of £380 per annum. When the payments for loan shall have ceased the sum of £1,180 may be added to this, and the profit would be £1,560 per annum.

South Shields.—A pamphlet has been issued by Mr. Joseph A. Jeckell, the borough electrical engineer, giving to the intended consumers some information as to the advantages and cost of electric light The mains are now being laid, and will shortly be completed in the following streets: East Holborn, West Holborn, Corporation-street, Church-row, Dean-street, Market-place, King-street, Ocean-road, Fowler-street, Westoe-lane (from Wellington-terrace to Victoria-road), Victoria road, Cuthbert-street, Green-street, Laygate-lane (from Green-street to Trinity Church), and Laygate-street. Persons in these streets who are desirous of having the current laid on to their premises should at once communicate with the borough electrical engineer, who will be very pleased to give them any information on the subject. The price which the Corporation have decided to charge is 6d per unit but after a consumer has used his maximum demand on an average for two hours per day, he will obtain the rest at 3d. per unit.

Leicester.—At the Town Council meeting Alderman Lennard moved the adoption of that part of the Gas Committee's report relating to the finances of the electric lighting works. He said, looking at the revenue account, they had spent £33,709, having still unspent £9,038. 13s. That was unspent in a certain sense, for they owed £3,000 or £4,000 of that for work actually done but not yet paid for. On the revenue account the gross profit was £580 on the working of the half-year. That was gained by £1,273 being raised for current, £34 for the rent of meters, and £266 for fittings. Turning to the profit and loss account, they found themselves with a net loss of £195. 7s. 2d. on the half-year's working. Considering that this was only the second half-year, he thought it was exceedingly satisfactory. The net loss up to the present from the commencement of the department was £1,337. 17s 8d., and the total amount held on sinking fund account was £1,296, so that, looked at from one point of view, there had been no loss on the undertaking at all. The report was adopted.

The Electric Lighting of Great North Trains —At the annual meeting of this Company the chairman (Mr. W. Ferguson, LL D) stated that they had now fitted up five first and third class carriages and two composites with the electric light. The five run on the Dyce suburban service, and the two are available for the main line. The Dyce carriages have been running for some weeks with perfect satisfaction, and the others have just been put on. On their first trial they ran to Elgin with a clear and steady light all the way. Each carriage is fitted with a generator and an accumulator, and the power is obtained from the revolving axle of the carriage. The accumulator provides for the keeping up of the steady supply of electricity during the periods when the train is at a standstill at the stations. The cost is about the same as oil. After a fair trial, the directors continue to be satisfied with the light, and they will no doubt apply it to the bulk of their

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plant. The apparatus is the invention of Mr. Gill, and the machines are supplied by Messrs. Stone and Co., of London.

Scarborough.—At the meeting of the Electric Supply Company last week, Mr. Swinton, referring to the saving that might accrue from adopting the electric light, read the following letter which had been received at the company's offices from Messrs. John Rowntree and Sons, 20 and 21, Westborough: "Dear Sir,—We send you, as requested, the following particulars of the cost of gas and electric light at 20 and 21, Westborough: cost of gas—1891, £38. 7s. 11d.; 1892, £34. 5s. 2d.; 1893, £36. 6s. 9d.; 1895, £8. 12s. 6d. gas and £20. 15s. 6d. electric light—£29 8s. We have 55 electric lights, varying from 8 c.p. to 32 c.p. Our premises are quite as well lighted now as previously with gas, though we have not increased the brilliancy. We have also added a gas-stove since putting in the electric light. The figures include the gas used for a small gas-engine, gas-stove, and two gas-rings. Practically, we use no gas for illuminating. This shows an average saving of over £5 10s. per year. We attribute it very largely to the care taken in not leaving the lights on when not required."

Hammersmith (London).—The committee dealing with the subject of electric lighting recommended the Vestry to appoint Mr. A. H. Preece as consulting engineer, and also recommended the acceptance of the tender of Messrs. Ferranti, Limited, for the sum of £12,302. 12s. The Vestry have adopted these recommendations. The Law and Parliamentary Committee reported having considered the letters from the London United Tramways, Limited, asking for the Vestry's consent to the provisional order promoted by them before the Board of Trade this session. By the order it is sought to exempt the company from the provisions of the London Overhead Wires Act, 1891, and the by-laws made under the Act, and to authorise the company, with the consent of the London County Council and the Vestry, to place overhead wires for working the tramways by electrical or other mechanical power, including the overhead trolley system of electric traction, or any other system. Having regard to the fact that the Vestry previously gave its consent to the company applying the overhead wire system to the tramways in Uxbridge-road, the committee now recommended the Vestry to give its consent to the present order. The report was adopted.

Liverpool.—The southern extension of the Overhead Electric Railway, which was entered upon last August, will in all likelihood be finished by August next. The extension begins about 150 yards north of the present terminus of the railway at Herculaneum Dock, and it consists of about 250 yards of iron viaduct and 800 yards of tunnel, both built for double line. The viaduct portion crosses Sefton-street, a corner of the Cheshire Lines goods yard, and part of the dock estate. Over the latter is a fine span of 220ft. The end of the extension is in Park-road, at the corner of the Dingle. To provide the additional power that will be necessary to work the extension and extra trains that will be required, two more engines and dynamos and new switchboard are being erected at the generating station, Bramley Moore Dock, which will then contain engines and dynamos capable of an output of 2,400 h.p. The new engines are being built by Messrs. Hicks, Hargreaves, and Co., of Bolton, and dynamos and new switchboard by Messrs. Thomas Parker, Limited, of Wolverhampton. The electrical equipment for the trains, which will consist of three carriages instead of two, is being constructed by the Electric Construction Company, of Wolverhampton.

Glasgow.—The Special Sub-Committee on Electric Lighting have reported that by the transference of the source of supply from John-street to Waterloo street station the cost of the electric light in the streets would be reduced to £22. 10s. 1d. per lamp, a saving of £6 10s. 4d. It has been agreed to request the students of the School of Art and the School of Design to send in designs for a wrought-iron bracket for continuing the existing lamps, and rendering them suitable for a pendant globe. The deputation appointed by the Corporation to obtain information in regard to the use of the electric light in various towns in England and Scotland have not yet completed their investigations. They visited Brighton, Portsmouth, and Blackpool. At the last meeting of the Electric Lighting Committee it was agreed that the officials of the committee should consider the question of the extended lighting of the city by electricity, and also investigate into the relative merits of gas lighting as compared with incandescent electric lighting for use in the subsidiary streets. In the meantime it was agreed to push forward the alterations of the lamps at the Charing Cross end of Sauchiehall-street, converting them from the present astragal form into hanging globes similar to those used in other cities. The committee felt on the whole question of the electric lighting of the streets that the effect of the Corporation having been comparatively early in the field was that they were suffering from many initiatory blunders that had been made, and that in carrying out further improvements they would profit by the experience they had gained.

Portsmouth.—The report of the Electric Lighting Committee presented at the meeting of the Town Council recommended that a joint committee, consisting of five members of the Electric Lighting and Roads and Works Committees, should be formed for the purpose of opening negotiations with the tramway company for the purchase of the tramway and for the leasing of the same to the company, and supplying the company with electrical energy for their cars upon terms to be mutually arranged, the committee to report progress to the Council. Alderman Ellis said the Portsmouth Company had gone to Parliament for power to run the overhead system of electric traction, and no doubt Parliament would grant their application, subject to the approval of the Corporation. His proposal was that the Corporation should purchase the plant and erect the necessary appliances, and then lease them to the tramway company at a rental of ½ per cent. over and above the amount the Corporation would have to pay as interest to the sinking fund. At the electric light station they had three huge engines, any one of which was capable of running all the cars in Portsmouth. At present the engines were working all day with no profit to the Corporation. He was sure that if the Corporation ran the trams they could hand over at least £4,000 or £5 000 a year to the borough funds. He admitted that the scheme would mean the outlay of a huge sum of money, but it would all come back to them in revenue. Last year every mile travelled by the trams cost the company 9d., and the takings for that distance amounted to 10d. If the scheme he had outlined came into force, he said the working expenses would be nearer 6d. an hour. Mr. Beale seconded, and the recommendation was carried.

Bristol.—It is stated that the advent of the electric tramcars has given a great impetus to the construction of dwelling-houses at St. George, Bristol. At a meeting of the Sanitary Committee the engineer reported an application of the National Telephone Company *re* their proposal of February 22 to place the main route of wires in the centre of the city underground. The engineer was of opinion that such a system would be desirable, as preventing in part the danger from overhead wires, and the necessity for unsightly posts. It had already been adopted by the Post Office on their trunk lines, and the committee had sanctioned several like applications from the Government department In those cases there had not been much trouble after the cables were once laid, but it might be a serious interference with the city traffic if the footways were constantly being taken up for extensions and repairs. The city electrical engineer reported that he had no objection to cables of the company being laid underground, as their currents could not affect those of electric lighting; but at the same time, as the company's wires would be close to those of the electric lighting department, the Corporation should be freed from all responsibility if their currents affected the working of the telephone wires. The company should be required to pay the wages of an inspector or inspectors from the electrical department to watch the progress of the work on behalf of the Corporation. A deputation from the National Telephone Company attended, and Mr. E. L Gane explained what it was the company required. In answer to a question from the chairman, Mr. Gane said by the laying of the main routes of wires underground some 50 or 75 per cent. of the overhead wires would be abolished. It was agreed that the district manager of the company should confer with the city engineer on the subject, and that a report should be presented.

London Lighting Extensions.—The Highways Committee of the London County Council have received the following notices under the Electric Lighting Acts and orders: two notices from the Metropolitan Electric Supply Company of intention to lay mains from the north-east corner of Lincoln's-inn-fields along the west side of Great Turnstile and a part of the north side of Whetstone-park, and along a part of the north side of Guildford-street and along the east side of Colonnade-mews; and two notices from the House-to-House Electric Light Supply Company of intention to lay mains on the east side of Queen's-gate from Harrington-road to No 114 and in Trebovir-road. In these cases the committee recommended that sanction be given. A notice had been given by the County of London and Brush Provincial Electric Lighting Company, under the County of London (North) Electric Lighting Order, 1892, of intention to lay mains on both sides of City-road between Old-street and Britannia-street. The greater part of the proposed works would be outside the company's area of supply under the order, and the Council have no power to approve of this portion of them. To avoid any misunderstanding, they therefore recommended that the Council formally disapprove the works referred to; that the company be informed that the Council have no power to sanction that part of the works which would be outside the area of supply under the County of London (North) Order, 1892, and that a fresh notice with plans should be submitted as regards that portion within the area of supply. The committee reported receipt of a notice from the Vestry of Hampstead, given in accordance with the provisions of the Hampstead Electric Lighting Order, 1892, of intention of lay mains in part of the north-east side of Shoot-up-hill, and part of the north side of Adamson-road. The Vestry was the undertaker under the order, and the Council had no power of approval or disapproval of these works.

Southampton.—The Corporation have decided to acquire the electric light and power company's undertaking. The matter has been arranged by the Works Committee, and their minutes which were read at the Council meeting, set forth the negotiations between the committee and the company. On March 10, in response to a letter received from Mr. James T. Hamilton, on behalf of the company, the committee resolved, "That the town clerk be instructed to point out, in reply to the communication, that the aggregate of the sums mentioned, amounting to £24,522, is practically the same sum as mentioned by the company's deputation on the 10th inst., and which the committee then informed the deputation they were not prepared to recommend the Corporation to entertain. That, without prejudice, the committee are prepared to recommend the Corporation to pay the company the sum of £20,000 as purchase-money for their undertaking and goodwill, and, in addition thereto, a reasonable sum for compensation to the directors and secretary for loss of fees and salary, and also the costs of formally winding up the company. That, with regard to these items, the committee are advised that the sum of £1,000 is ample, and this sum they are prepared to recommend. That the

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town clerk be instructed to further point out that the company's provisional order does not authorise the company to supply electricity beyond the limits of the old borough, and it would therefore be necessary for the Corporation, even if they acquired their undertaking, to go to the expense of a provisional order to enable them to supply the area of the extended borough." Subsequently a letter was received from Mr. Hamilton stating that his board instructed him to accept the offer, subject to the following conditions: "(1) That the Corporation take over the company's liability on its debentures at par value in reduction of the purchase-money; (2) the Corporation is to take over the company's stores and stocks at a valuation, and to reimburse the company all capital expenditure since December 31, 1895; (3) the Corporation to take over all existing contracts entered into by the company." On this understanding the Works Committee recommended the Council to purchase the undertaking of the Southampton Electric Light and Power Company, Limited, for the sum of £21,000, such sum to include all preliminary expenses, goodwill, license, and provisional order, and the cost for charges and expenses to be incurred in winding up the company, and vesting the undertaking in the Corporation, and the Corporation to take over at a valuation the stock of stores of the company, and to reimburse the company the sum of £55. 18s, the amount of capital expenditure since December 31, 1895, and to take over the existing contracts for stores, coal, etc, entered into by the company, and that application be made to the Local Government Board for a loan of £50,000 to complete the purchase and to carry out the necessary extensions of the undertaking These recommendations were carried by 29 votes to 4, and eight members did not vote.

PROVISIONAL PATENTS, 1896.

MARCH 16.

5779. An improved automatic telephone switchboard specially adapted for private installations. Dennis McNamara, 3, Abercorn-terrace, Inchicore, Dublin.

5794. A new or improved manufacture of insulating material for underground electric wires, cables, or the like. Paul Raoul de Faucheux d'Humy, 6, Lord-street, Liverpool.

MARCH 17.

5872. An improved electric lift. James McLaren, Dersingham, Norfolk.

5874. Improvements in carbon pencils for the electric arc light. Thomas Cradock Hepworth, 10 Lysias-road, Balham-hill, London.

5884. Improvements in electrical switches. Robert Brymer, 70, Market-street, Manchester.

5951. Improvements in the suspension of motors for electric or other cars. James Devonshire, 70, Chancery lane, London. (Norman C. Bassett, United States.) (Complete specification.)

5980. Improvements in electric switches. Albert John Bonnella, 22, Southampton-buildings, Chancery-lane, London.

MARCH 18.

6001. A new form of vacuum tube for utilising the Rontgen "x" rays. Herbert Charles Newton, 3, Fleet-street, London.

6048. Improvements in controllers for electric motors. James Devonshire, 70, Chancery-lane, London. (William B. Potter, United States) (Complete specification)

6058. An improvement in electric primers for firing guns. The Morris Tube Ammunition and Safety Range Company, Limited, Charles Cuthbertson, and William Henry Stentiford, 28, Southampton-buildings, Chancery-lane, London. (Complete specification)

6068. Improvements in moderating electric incandescent lamps and apparatus for that purpose. Godfrey Bamberg, 33 Barcombe-avenue, Streatham hill, London.

6069. Improvements in the method of electrically coating wire and apparatus therefor. William Stepney Rawson, 21, Greycoat-gardens, London.

6071. Improvements in primary electric batteries. Walter Rowbotham, 45, Southampton-buildings, Chancery-lane, London.

MARCH 19.

6113. Improved apparatus for adapting telephone line wires for fire-alarm signals and similar purposes. Alfred George Burrell, 5, King street, Sheffield.

6148. Improvements in fittings for electric lighting. Henry Lea, 3, Cherry-street, Birmingham.

MARCH 20.

6197. A new or improved underground system of electric traction. Thomas Edward Doyle and James McKenny, 9, Westland-row, Dublin.

6208. Improvements in automatic electric switches. Arthur Ballance and Everett Hebden Hewson, 8, Quality-court, Chancery-lane, London. (Complete specification.)

6216. Improvements in and relating to the treatment of sodium and potassium chlorides by electrolysis. Charles Henry Parker and John Pullman, 65, Chancery-lane, London.

MARCH 21.

6269 Improvements in wooden and similar casings or mouldings for electric conduit wires and cables. Charles John Wightman and Arthur Hudson, 2, Market-street, Bradford.

6305. Improvements in surface trolleys for electric railways. William Sharkey Hull, 323, High Holborn, London. (Complete specification.)

6306. Improvements in electric motors Arthur Greenwood, 6, Bream's-buildings, Chancery, London.

6329. Improvements in apparatus for producing, storing, and applying electricity, especially applicable to the lighting and heating of railway carriages and other vehicles. Edwin James Preston (of the firm of J. Stone and Co) and Arthur Bernard Gill, 77, Chancery-lane, London.

SPECIFICATIONS PUBLISHED

1882

1368 Electric cables. Dolbear. (Third edition.)

1894.

25312 Arc lamps. Hewitt and Casey.

1895.

4065 Electric tramways and lifts. De Ferranti.

5137 Electric transformers. De Ferranti.

5984. Telephony. Bentley.

6035. Electric conductors. Rossiter.

8081. Secondary and primary batteries. Sanschieff.

8167. Electrically heated ironing, etc, appliances. Labre and Cousinet.

8222. Telephonic systems Kingsbury. (Western Electric Company)

8564 Electric alarms. Duceux.

20626 Arc lamps Branson.

1896.

880. Electric heaters. Ewart and Vaughan-Sherrin.

1575. Electrolytic production of zinc. Siemens Bros. and Co. Limited. (Siemens and Halske)

1611. Incandescent electric lampholders McGeoch.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6¼
Brush Company, Ordinary	3	1⅛-1⅜
—— Non. Cum, 6 per cent. Pref.	2	1⅛-1⅜
—— 4½ pe cent. Debenture Stock	100	110-113
Charing Cross and Strand	5	7⅛-7⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7⅛-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	8	10½-11½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2⅛-2⅜
Edison and Swan United Ordinary	3	1⅛-1⅜
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅛-1⅜
—— 7 per cent. Cumulative Pref.	2	2⅛-2⅜
Elmore's Copper Depositing	2	⅝-¾
Elmore's Wire Company	2	⅝-¾
Fowler-Waring Cables (*Reconstructing*)	5	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	16½-17½
—— 7 per cent. Preference	10	17-18
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	3⅛-3½
—— 7 per cent. Preference	5	7⅛-8½
India Rubber and Gutta Percha Works	10	20-21
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge Ordinary	5	8⅛-8⅜
—— 6 per cent. Pref.	5	7⅛-7
Liverpool Electric Supply, Ordinary	5	7⅛-7⅜
Liverpool Overhead Railway	10	13⅛-14½
—— 5 per cent. Pref.	10	16⅜-16⅝
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	⅝-¾
Metropolitan Electric Supply	10	12½-12⅝
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	6⅛-7
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref	5	6⅛-6⅜
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	8⅜-9½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8⅞
—— £4½ shares	4½	7⅛-7⅜
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4⅜-5½
St. James's and Pall Mall, Ordinary	5	9⅜-10½
—— 7 per cent. Pref.	5	9½-10
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	6-6½
Westminster Electric Supply, Ordinary	5	9½-10
Yorkshire House-to-House	5	7-7½

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NOTES.

Telautograph.—It has been stated in the *St. James's Gazette* that the telautograph is about to be adopted by the National Telephone Company, in addition to their ordinary service.

Personal.—We were pleased on Monday last to receive a call from Mr. Gisbert Kapp, who is paying a hurried visit to London. He informs us that the Verband Deutscher Elektrotechniker, of which he is secretary, is doing good work for the profession in Germany. Amongst the recent work of the society, the wiring rules deserve special mention. In these the radical departure of forbidding the use of wood casing has been made.

What, When, and Where.—The general meeting of the Chesterfield and Midland Counties Institution of Engineers is fixed for to-morrow (Saturday, April 4) at Derby. On Wednesday, 8th inst., the students of the Institution of Civil Engineers are to visit the works of the Waterloo and City Railway, assembling at 15, Upper Ground-street, Blackfriars, at 2.30 p.m. On the same date there will be a meeting of the shareholders of Willans and Robinson, Limited, at the Cannon-street Hotel, at 3 p.m.

Parisian Installations. — The Paris Bureau de Controle, which periodically looks after the electric installations of its subscribers, reports that its inspectors have paid 426 visits and presented the same number of reports. It is stated that a great number of installations—more than half—were found more or less defective—otherwise, what would be the good of the bureau ?—and have been put right. The bureau has also undertaken to determine the actual efficiency in watts per candle-power of incandescent lamps. That is a thing the consumer decidedly wants to know.

The Metric System.—At a recent meeting of the council of the Leeds Chamber of Commerce a letter was read from Sir Albert Rollit, M.P., to Colonel Harding—which the latter desired should be communicated to the chamber—on the subject of the metric system. Sir Albert stated that he had seen Mr. A. J. Balfour with regard to the adoption of the system, and the right hon. gentleman had said that it was a subject he had promised to consider, and, having done so, he was in favour of the metric system being adopted, and thought his colleagues in the Cabinet would be guided by his advice.

Liverpool Electric Railway.—On Monday, as previously announced, the Duke and Duchess of York, who were visiting Liverpool, took a trip on the overhead electric railway. At the station the party were received by Sir William Forwood and others, and on the platform the Duchess of York was presented with a bouquet by Miss Forwood. At five minutes to one o'clock the party entered a special train and proceeded north to the extreme end of the docks, and then south to the Herculaneum Dock, returning about ten minutes past two to the Custom House Station. The ordinary traffic along the line was suspended.

Motorcars.—It is stated that a horseless carriage competition has been organised by the *Cosmopolitan* magazine in New York for a prize of £600, and the services of a distinguished committee of judges have been secured. The award will be made upon the following points, the maximum being 100: speed, 35; simplicity of construction and durability, 30; ease in operating and safety, 25; cost, 10. Fifty-two miles will be covered in the test, over excellent roadway. The names of the judges are General Miles; Mr. William P. Craighall, chief of Engineers, U.S. Army; Mr. H. Walter Webb, vice-president N.Y. Central and H.R.R.R. Company; and Mr. John Jacob Astor. The date of the competition is May 30.

Geneva Electrical Congress.—It has been stated by *L'Elettricità* that the electrical congress which it is proposed to hold this summer at Geneva, on the occasion of the exhibition there, is to be of a practical rather than a scientific character. It is to last about four days. Only morning sittings will be held, so as to leave the afternoon free for visits to the exhibition. A dinner, excursions, and visits to some of the large water-power installations are to be arranged for. The fee is 20fr., which will include entrance to the exhibition; but all arrangements are contingent upon a sufficient number of subscribers presenting themselves.

Carbide of Zirconium.—In a note presented to the Paris Académie des Sciences by Messrs. H. Moissan and Lengfeld, a description is given of a carbide of zirconium prepared by means of the electric furnace. It is a crystalline substance of a composition corresponding to the formula ZrC, and is not decomposed by water. It is remarked that this is somewhat curious from a theoretical point of view, since the carbide of thorium, which belongs to the same set of elements in Mendeleieff's classification, decomposes water with the production of hydrogen and hydrocarbons in the usual way. In reference to this, even if thorium is rightly placed, it must be remembered that zirconium lies much nearer to silicon and carbon itself. The carbides of the intermediate elements may possibly bridge the gap.

Cable Interruptions. — From the list of cable interruptions for last month published by the Bureau International des Administrations Télégraphiques in the *Journal Télégraphique* of March 25, it appears that the Zanzibar and Mombasa cable broke down on March 6. Communication was re-established on the 9th, but the Aden and Zanzibar section failed on the 16th, and had not been renewed up to the date of publication. An interruption of the Ceara-Pernambuco cable on March 3 was repaired the same day. The two interruptions of old date on the Brest to St. Pierre cables, as well as those of the Puerto Plata and Martinique, dating from December 19, and the South African Transcontinental land line beyond Mazol, come also in the list of "communications not re-established."

Water Power.—According to reports from America, Mariposa County, California, is to have one of the largest electrical power developing and distributing plants in the United States. It will be at the Horseshoe Bend, on the Merced River, near the centre of a mining district having at least 100 mines that are sufficiently prospected to use cheap power. At the driest season of the year the power company reckons upon 1,800 h.p., and during eight months in the year they expect water enough to generate 3,500 h.p. The price the company proposes to charge its customers is £1 per horse-power a month. At the present time the expense of producing steam is from £2. 8s. to £3 per horse-power, and two years hence, at the present rate of consumption of wood, the hills would be bare of timber, and steam power, except in a few localities, at a price almost prohibitive.

Imperial Institute.—Her Majesty's Commissioners for the Exhibition of 1851 have just considerably increased their annual grant in aid of the work carried out in the department of scientific and technical research of the Imperial Institute, and the executive council of the institute have consequently decided to take active steps for the development of this department. A laboratory having been fitted up, and, as far as possible, equipped in 1894, with the aid of funds provided for that purpose by the Goldsmiths' Company, the operations of the scientific department commenced in October of that year under the temporary direction of Sir Frederick Abel. The council

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of the institute have now appointed Prof. Wyndham R. Dunstan, M.A., F.R.S. (hon. secretary of the Chemical Society), as director of this department, to the staff of which other additions are contemplated.

Lighting a Channel.—Dr. E. L. Corthell has described briefly in the *Scientific American* the system of electrically-lighted buoys used to mark out the channel into New York Harbour. Originally a direct current was used, but this was changed to an alternating current, and the size of the conducting cable reduced from 1⅛in. to ·78in. The experience gained at Chicago with a cable laid in the water from the Exposition to the city, about seven miles, and further study and experiment, led to the very satisfactory method only recently installed at Sandy Hook, as mentioned above. The spar buoys used are juniper wood 50ft. long, held in place by mushroom anchors weighing 4,000lb. The lamps, which are attached to the top of the buoys, are 100 c.p. of a new design, with 5in. globes. The length of the cable used is about 6¼ statute miles, with an additional length of nearly two miles to the South-West Spit Buoy.

Roman Trams.—In the course of a discussion at the Society of Arts following on a paper by Mr. Parshall on electric traction, Mr. W. H. Preece referred to the application of electricity to lighting and tramway working in Rome which he had recently inspected. The current was generated 18 miles off, at Tivoli. The water power there worked six turbines, giving in all 2,000 h.p. This was converted into alternating currents at an equivalent of 6,000 volts and transmitted to Rome, where it was transformed down to 110 volts and used for lighting. The day load remained available to work the tramways. The alternating currents were transformed down, rectified, and used to charge a very large accumulator of 304 cells and 1,200 ampere-hour capacity. During the day the trams were worked direct, and the accumulator was used to carry over the period during which the tramway service and the lighting overlapped, as well as to maintain a constant pressure at other times.

Electric Dredger.—According to the *Schweizerischen Bauzeitung*, trials of an electrically-driven dredger have taken place at the yard of Messrs. A. F. Smulders at Slikkerver, Rotterdam, which are of some interest. The design is due to Mr. Bunan Varilla, and the dredger is intended for excavating work in the bed of the River Esla in Spain. The plant includes a 150-h.p. steam-engine and a three-phase generator with stationary armature and rotating field. The potential is 2,000 volts, and the current is taken from the river bank to the dredger by a cable, and there transformed down to 200 volts. All the work of the dredger is done by motors, so that the crew is reduced to a minimum and the draught of the boat is very light. This is obviously an important matter in a dredger. In reference to this craft the *Elektrotechnische Zeitschrift* reminds its readers that at Jena there is at work an electric dredger which excavates gravel and sand for industrial use from the bed of the River Saale.

Small Station Steam-Engines. — Prof. R. C. Carpenter, in the course of a long article in *Cassier's Magazine*, has discussed the question of the proper steam plant for a small electric light and power station. He prefers automatic—*i.e.*, slide-valve—to throttle governing. The main trouble in selecting an economical engine is to provide for the varying load, as the economy which may be obtained with engines of the poorest type when fully loaded is better than that with engines of the best type having a very light load, so that it may be advisable to suffer the loss of several small engines working at fairly good loads than from one large engine working with very light loads. In the case of an electric railroad station, where the change of load is almost instantaneous, the most satisfactory method seemed to be to use so small an engine that it should be operated in a condition usually considered an overload when meeting the maximum requirement. This will involve a heavier crank-pin, shaft, piston-rod, etc., than the usual practice warrants.

Steam Warping.—Ever since 1856 steamers have pulled themselves along the River Seine between Monterean and Rouen by hauling in and paying out behind a chain running along the bed of the river. Mechanical difficulties immediately present themselves in the way of securing a sufficient grip of the chain to prevent slipping on the windlass without at the same time so tying the steamer up to the chain, that passing is rendered dangerous and difficult. The method of progress is an exceedingly economical one, especially where heavy loads have to be towed, and it is probably the difficulties alluded to that have prevented this system of river navigation spreading outside France. In the *Revue Générale des Sciences* it is, however, stated that Mr. de Bovet has got over the trouble by using a magnetic windlass about 47in. in diameter, around which the chain makes only three-quarters of a turn, and from which, therefore, it can be much more easily removed. Three vessels have been fitted in this way, and the results are said to be entirely satisfactory. Two subsidiary pulleys, one of which is also magnetisable and in gear with the machinery, keep the chain in contact with the main pulley. A current of 35 amperes, giving an equivalent of 28,000 ampere-turns, is stated to be used, but no details are supplied as to the winding.

American Patent Disputes.—The fight that has been going on in the United States between the General Electric Company and the Westinghouse Electric and Manufacturing Company has at last ended in a compromise. For nearly a year those largely interested in the two companies have been endeavouring to come to some arrangement which would reduce the competition between the two concerns, which are the largest manufacturers of electrical appliances in the country. The rivalry between the companies has been great, and it is said that the patent litigation between the two companies has cost several million dollars in legal expenses and for the services of experts. The result of this litigation has been to increase competition, lower prices, and benefit many smaller concerns. It is now stated that an arrangement has been made for a joint use of the patents of the two companies, subject to existing licenses, on terms which are considered mutually advantageous, and the patents are to be managed by a board of control, consisting of five members, two appointed by each company and a fifth selected by the four so appointed. The especial incentives which have led to the arrangement are the recent decisions in favour of patents of the General Electric Company controlling the overhead system of electric railways, the approaching trials on a number of other important General Electric patents on controllers and details of electric railway apparatus and systems and other electrical devices, and the equally strong position of the Westinghouse Company in respect to power transmission, covered by the patents of Mr. Nikola Tesla and others.

Junior Engineers.—A conversazione was given on Saturday night at the Westminster Palace Hotel by the Institution of Junior Engineers, and was well attended. The guests were received by the president (Mr. Archibald Denny, M.I.N.A.) and the chairman (Mr. H. J. Young) and Miss Young. So far as the exhibits were concerned electricity was very much to the fore, at least one-third of them being electrical. Not to mention Mr. Wimshurst

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and his machine, there were apparatus for electric welding, electric cooking, postal telegraph instruments from the General Post Office, while the electrophone-room was in connection with about eight of the theatres. The new photography is now a matter of course everywhere, and a quantity of Mr. Campbell Swinton's work was shown, and the process demonstrated, while upstairs Mr. Leslie Miller exhibited an instrument equivalent to Prof. Salvioni's cryptoscope, or, as it now seems in danger of being called in this country, a crytograph. Though the circumstances were somewhat unfavourable, this was a popular and successful exhibit. For the rest, Mr. Robert Paul showed his theatrograph, mostly pictures of dancers, on the principle that if the theatrograph can do a skirt dance it can do anything. Mr. E. Basil Wedmore showed his four-pendulum harmonograph, not the least interesting part about which is the way Mr. Wedmore makes silk threads do the work of universal joints, and uses grooved drawing pins and wood screws where one would expect a knife-edge and agate plate. There were short concerts of instrumental and vocal music, including violin solos by Mr. T. E. Gatehouse, songs by Miss Lane, Mr. Kenneth Gray, and humorous musical selections by Mr. H. H. Preston, in addition to a programme of music by Mr. W. Day's band. When there was not music, Mrs. Lynd showed the Edison-Bell phonograph.

Electric Railway Traction.—In the course of a series of articles in the New York *Electrical Engineer* on the subject of electric traction on railways, Mr. Baxter discusses the coal consumption on steam and electric railways, and estimates that the coal consumption of locomotives will average 4lb. per horse-power per hour for express engines, 5lb. for local passenger and 6lb. for freight trains. The cost of a unit of energy developed on the track by electric motors would be about 44·5 per cent. of what it is with steam locomotives as far as the coal bill alone is concerned, and therefore the saving in favour of electricity would be less than 2¼d. per train mile. As the average yearly run of a locomotive in America is about 30,000 miles, the annual saving in coal per locomotive would be over £260, which, however, is not considered to be enough to make the adoption of electricity justifiable on existing railways. Nevertheless, the incidental advantages of electric traction, taken altogether, would go far towards offsetting the cost of power stations, trolley lines, and feeders, and in equipping a new line would leave only a small percentage in favour of steam, so small, indeed, that the reduced cost of operation due to the saving of coal would render the electric system more profitable, except where coal is very cheap. From the reports of 10 of the largest railways it appears that the percentage of the coal bill to the total operating expenses averages about 10 per cent., being as low as 6 in one case and as high as 18 in another. The coal consumption of freight locomotives is much greater per horse-power than the figures claimed for high-speed passenger engines, and therefore it would seem that the opinion generally entertained that electricity would not have much of a chance competing with steam for freight service is not well founded. On the contrary, Mr. Baxter contends that if it can compete with steam at all it will be for heavy freight traffic. On account of the slow speed of freight locomotives their efficiency is much lower, and in addition to this such locomotives are often side-tracked for a considerable time, during which a certain amount of coal is burnt without doing work.

Resistance of the Arc.—A number of experiments have been described by Dr. Arons in *Wiedemanns Annalen* which have a bearing on the question whether there is a counter E.M.F. in the electric arc. Stenger some time ago connected a galvanometer in series with the arc, and arranged it that the needle could deflect only in the opposite direction to that produced by the original current. On short-circuiting the dynamo no deflection was produced in the galvanometer by the action of the supposed counter E.M.F. When, however, some accumulators were put in circuit, which were charged by the original current, they produced a strong current under the same circumstances, and he considered this a proof that there was no counter E.M.F. in the arc. Dr. Arons, however, thought this was not conclusive, as the limit was not found of the E.M.F. of the battery which the voltage must have to produce the currents between the carbons, and made researches to find this limit. That there was such a limit, he concluded from the fact that an alternating arc between the carbons was possible. With a resistance of 0·4 ohm, 18 volts of the accumulator battery was necessary to produce a deflection of the galvanometer—that is, to pass a current through the gaseous space between the carbons; to produce an arc in the opposite direction 30 volts were required, but the arc continued only for a few seconds. For a continuous arc 70 volts were required. From this he concludes that there is a counter E.M.F. which vanishes very rapidly. With metallic electrodes no signs of a momentary current after short-circuiting could be obtained, even though the voltage of the battery was 76. From this it would seem to follow that an alternating arc between metallic electrodes was not possible, unless the voltage reached that required for sparking across. Between carbon and metallic electrodes an alternating arc can be maintained, the light from which shows the lines of that metal in the spectroscope. Dr. Arons' conclusion is that as the heat conductivity of the carbon is less than that of the metals, its temperature on striking the arc is higher, and that between glowing electrodes a current will be produced even with comparatively low voltage, and it is possible that these weak currents allow the arc to continue. Metals produce only their own vapours, while carbon gives off gases which will probably last longer than the vapours of the metals. Again, the whole of the products of the carbon are gaseous, while the metallic electrodes are soon covered with oxidising, non-conducting layers which may possibly act to prevent the arc from relighting.

Cold Light.—In the course of an article in the New York *Electrical World*, Mr. W. M. Stine discusses the conditions, so far as they are known, that would have to be complied with in order to produce light radiations alone without the accompaniment of an altogether disproportionate quantity of invisible vibrations of lower period. The problem is to produce ether waves with periods between 400×10^{12} and 750×10^{12}. To produce "cold light" it will not suffice to merely set up transverse vibrations in the ether, but such vibrations must be strictly controllable within the limits of visible rays. As to the possible methods of impressing such disturbances on the ether, given matter and ether, how may the former affect the latter? According to ordinary views of the ether, waves in it can have but small amplitude, and can therefore be established only through the agency of molecular and not molar masses. What may be termed the inertia-time-constant of a molar mass, however small, is too great to set up true ether waves. In such cases the ether must simply flow around the moving mass. As well might sound waves be attempted by moving a door rapidly on its hinges. The problem thus narrows down to the molecule, which is sufficiently rapid in its movements to exceed the inertia-time-constant of the ether particles, which thus suffer a true displacement rather

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than a movement of flow around the disturbing matter. Could the molecule be given a governable period of vibration, the problem would be nearer solution. Spectrum analysis shows that the molecules of the different elements have a very different capacity for vibration in different wave periods. In other words, some spectra have few and others a great number of lines. Unfortunately, when energy is imparted to molecules to render them luminous, the greater part of the energy is radiated in waves of large magnitude and long period or heat waves. Light, so far as is known, is only the result of a molecular impact or collision, so it would seem impossible on such lines to avoid heat waves. It must be further emphasised that the light-producing molecules must not be gaseous, but constituents of very minute solid particles, since the total mass of a gas is too small to transform any considerable amount of energy or produce a light of much intensity. In illumination by fluorescence the vibrations are set up by impact of rapidly-moving gaseous molecules on those of a solid. This gaseous bombardment must necessarily be associated with a certain heat waste. On the other hand, the direct production of ether waves by an alternating electric charge would seem to require apparatus of dimensions as small as a molecule, so that this method would appear to be hopeless.

Rontgen Radiations.—The surprises of the new photography are by no means exhausted. The last is contained in a letter written by Messrs. L. J. Atkinson, A. H. Pook, and R. P. Williams to *Knowledge*. On exposing a plate enclosed in an ordinary cardboard plate-box "with the object of obtaining a shadowgraph of keys, coins, etc., on the top," these gentlemen failed to obtain the usual image, but on exposing another plate in the same box, after a trifling alteration of apparatus but with an entirely different set of objects, a good image was obtained, not of the second set of objects, but of the first. A similar result was secured when an interval of as much as eight days was allowed to elapse between the two exposures, and the box was in the meantime exposed to strong sunlight. Curiously enough, the effect was only to be obtained with that particular box, and endeavours are being made to obtain more like it of the same batch. All that can be said on the subject at present is that the transmission of the Röntgen effect through that particular box involves some process entirely different from the transmission of ordinary light radiations. If so, any amount of theory goes at once. It is, of course, possible to invent an explanation by supposing a molecular change to take place which renders an originally opaque substance ultimately transparent, and which, on the basis of a gradual breaking down under continued battering of the molecular grouping that opposes the passage of the radiations, would undoubtedly require a definite time to accomplish. But in that case, a superposed image of the second group of objects would be obtained, which does not seem to have happened, and the plate-box would then always give normal images. It is, however, better to wait for the further experiments which are promised, and from which the discoverers of this remarkable phenomenon hope to elaborate a definite theory of it. It may be noted that the same issue of *Knowledge* contains some very beautiful reproductions of Röntgen photographs produced by Mr. J. W. Gifford. Incidentally, it appears that that gentleman is by no means inclined to abandon as hopeless the hypothesis that the Röntgen radiations may be, as was here suggested at the beginning, merely very long waves, though not so long as the Hertzian waves. The actinic effect he considers to be due to overtones of these waves set up in the sensitive plate. Attention may be called to the discussion at the Physical Society on the "Edison effect," which has considerable bearing on the nature of the cathode rays and what really takes place in a high vacuum subjected to electrical stress. Before leaving the subject it may be added that Prof. Oliver J. Lodge has written to the *Times* stating that at Liverpool the new radiations have been transmitted through the bodies of two men standing one behind the other, and that Röntgen photographs of an injured vertebra and an intestinal lesion have been obtained at the Liverpool Royal Infirmary after exposures of half an hour and 10 minutes respectively. A "focus tube" and a powerful ordinary induction coil were the means used.

The Metric System.—In the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders there is published a communication by Mr. G. H. Baines on the report of the House of Commons Committee on the metric system. It is pointed out that evidence was given before the committee by about 20 witnesses representing official, commercial, manufacturing, trade, educational, and professional interests, and these were practically unanimous in favour of the change. The engineers included Mr. Alex. Siemens, Mr. Emerson Dowson, Captain Sankey, and Sir Benjamin Baker, all of whom favoured the change, while Sir Frederick Bramwell proposed to have the old and the metric system running side by side. Lord Kelvin's testimony was that the present was a "brain-weakening and time-wasting system which ought to be abolished." Mr. J. C. Stevenson, who is connected with both the chemical manufacturing and shipping interests, was the only member of the committee who was opposed to the metric system. His idea was to take the existing foot, gallon, and pound and use decimals of these, all other measures to be dropped. This would do very well if we had no foreign trade to consider, but when the change is made it may just as well be such a one as will not make it necessary to have one set of patterns for home and another for foreign use. It may be added that the London Association for the Protection of Trade, which has about 4,000 members, the majority of whom are retail traders, has sent a petition to Parliament urging that the recommendations of the Select Committee should be adopted. The Rochdale Merchants' and Tradesmen's Association has petitioned outright for the compulsory adoption of the metric system. The Edinburgh Merchants' Association, the Hull Guardian Society, the Association of Trade Protection Societies, the Manchester Guardian Society, and the Munster Merchants' Associations, all representing retailers rather than merchants, have expressed themselves in favour of the change; and similar institutions in Heckmondwike, Wimbledon, Southam, Bolton, and Merthyr Tydfil have passed resolutions for the adoption of the metric weights and measures. In Liverpool the Cotton Association, Corn Trade Association, General Brokers' Association, Salt Chamber of Commerce, Shipowners' Association, West India Association, Woolbrookers' Association, Warehouse Association, Provision Trade Association, and the Iron and General Metal Trades Section of the Liverpool Chamber of Commerce have expressed themselves in favour of the recommendations of the Select Committee. From all this it looks as though something might be done at last. Whatever could be said for them on their merits, it is obviously too late for proposals like Mr. Stevenson's. The few outstanding nations are fast adopting the metric system, so that soon England and the United States will stand alone in resisting it. The last adhesion is that of Turkey, and in order that the change there should be a real and not a nominal one, the local authorities have received instructions to call together the various trade corporations

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in order that they should provide themselves with weights and measures in conformity with the new system.

The Baltimore Electric Locomotive.—In the New York *Electrical World* some interesting information is given as to the results of trials made with the electric locomotive used for hauling trains through the Belt Line tunnel of Baltimore. By its means a reduction of 16 minutes in the running time of the "Blue Line" trains between New York and Washington is now made possible, and it is probable that this saving will be increased later on. Probably the most striking test of the power of the locomotive was when two trains were coupled together and hauled through the tunnel. For some reason the freight trains had become "bunched" on the Washington division, and when they did get through they came so fast that it was decided to have the electric locomotive haul them two at a time. The first composite train, therefore, consisted of 44 cars, loaded with coal and lumber, two regular steam freight engines and a steam "pusher" engine. The whole weight was approximately 1,900 tons, and was equivalent to about 52 loaded cars. The steam locomotives did no work to assist the electric locomotive. The start was made easily and gradually, but when the train was in the tunnel and entirely on the grade the steady, heavy pull was too severe on a defective coupling near the head of the train, and it parted. After coupling together again, the electric locomotive started the heavy train, with all drawbars stretched—no slack in the train—and accelerated it to a speed of 12 miles an hour without slipping a wheel, and in every way with the greatest ease. It reminded one of the start of an ocean steamship, so noiseless was it and free from any manifestations other than those of mighty power. The current recorded on the ammeter was about 2,200 amperes during the acceleration period, and after the train was up to speed it settled down to about 1,800 amperes. The voltage on the line was 625. By reading the amperes the drawbar pull was readily computed and found to be about 63,000lb. All four motors were in series. The conductor in the tunnel has now been in position for nine months. During all of this time coke-burning locomotives have been used for passenger service with the consequent presence of a good deal of gas and vapour. Current was first turned on the line about three months after the tunnel structure was erected. The leak at first was about 21 amperes, but in a day or two this dropped to about four amperes—the present leakage. The inside of the conductor became coated with a combined deposit of rust and muddy sediment. Heavy currents were taken from it by the contact shoe only with difficulty and the presence of much arcing, heating, and showers of sparks. By applications of kerosene and frequent scraping with special shoes, a direct contact of the trolley shoe with the conductor was made possible. Although a single-contact shoe then worked with little or no sparking, two shoes in tandem were adopted. At intervals of about three weeks the conductor is now treated with kerosene, and brushing shoes are run through it. About one or two trips with these brushing shoes are all that is necessary, and this serves to prevent further accumulation of rust and to remove the sediment from the contact surfaces. No considerable sparking now occurs, except at the wet places, where it is occasioned by the presence of water and sediment. With the exception of three places, about 200ft. long each, the conductor is at present dry.

Electric Power in Gold Mines.—A short time ago the *Financial News* published an article on Barberton mining, in the course of which it was mentioned that the experimental crushings of gold ore had been hampered by want of water, and also by the uncertainty of the electric power used to drive the stamps. Further, it was said that steps were at once to be taken to substitute steam for the electric power now used to actuate the battery; electricity had been adopted, not because it was the best form of power available, but because Moodie's Exploration and Gold Mining Company was willing to put up an experimental installation, and the Fortuna people gave it a fair trial. They found that it is not to be depended on, and is not adequate for the requirements of the mine. These remarks drew from Mr. W. B. Esson, M.I.C.E., M.I.E.E. (chief engineer to Messrs. Johnson and Phillips), who erected the plant at the Sheba Mine, a letter to show that, properly engineered, power transmitted electrically can be made as reliable as power obtained by any other means, steam included, and that the uncertainty of the electric power at the mine in question, due to whatever cause, cannot be held as condemning in any sense the use of electric power generally. He says that by a curious fate the Sheba Mine, which might be called next door to Moodie's, has also an electric plant, and has for 12 months depended solely and absolutely for its crushing on power transmitted electrically. By a still more curious fate, while Moodie's Fortuna records a failure, the Sheba has recently recorded crushings which have been unprecedented, and which bear ample evidence of what electric power can do. The difference in results may to a large extent be attributed to the fact that at the Sheba Mine two alternating currents are used, while a direct current is used at the neighbouring mine. "The results at Sheba speak for themselves. The electric power is transmitted through cables five miles long, and the mill works night and day, never stopping save for an occasional examination of the machinery at the generating or receiving end of the lines. For the four months ended February 29 the mill worked night and day, with stoppages aggregating in that time only one day and a half in all. The record as it stands forms an undeniable tribute to the success of power transmission by electricity, and it will be obvious that what has been done at Sheba can be done elsewhere, if the problem be tackled in the right manner." Following on this came a letter from Mr. H. K. Baynes, on behalf of Messrs. Easton, Anderson, and Goolden, Limited, endorsing Mr. Esson's remarks. Mr. Baynes says that "to supply any plant, whether the motive power be electricity, steam, or anything else, it is necessary to know beforehand the conditions under which it is to work and the amount of power required. Neither of these factors were known in the case of Moodie's. The calculations as to the quantity of power required were prepared at Barberton, and embodied in a specification, and the plant supplied by Messrs. Goolden and Co. was designed to produce, and, in fact (as certified by Moodie's consulting engineer), produces the quantity specified. It now turns out that these calculations were quite incorrect, and that the quantity specified is altogether insufficient for the work required. Thereupon the uninitiated hasten to fall foul of electricity as a motive power, forgetting that as they cannot expect 50 h.p. out of a 5-h.p. steam-engine, so they cannot hope to extract from a dynamo or motor more current than it is constructed to supply. They should address their complaints to the gentlemen who are responsible for the miscalculations in question, and not to the contractors, who supplied exactly that which they were asked to supply." With every possible deference to our contemporary, we would suggest that the whole question is which is the easier to get, coal or water power. Neither are particularly cheap at Barberton. There is no difficulty in making an electric motor to work quartz crushing stamps.

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ELECTRIC TRACTION ON RACK RAILWAYS.

BY FRANK B. LEA.

There are several reasons why the use of electric energy as the propelling power on rack railways should offer great attraction to the engineer as well as the management.

In the first place, the adoption of rack working implies grades too steep for ordinary adhesion locomotives—that is, implies that the line in question is situated wholly or largely in a mountainous region. Therefore, it may safely be concluded that in seven cases out of ten there is a tolerable amount of water power close at hand which can be brought into service at small initial expense to furnish a very cheap supply of energy for the trains.

Secondly, the weight of locomotive when operated by electric energy may be, and usually is, very much less than when steam power is employed, seeing that neither boiler nor tender, with coal and water, is required. This leaves, accordingly, a greater weight for the train load, and a larger net paying load, for a given locomotive horse-power, other conditions being also equal.

In the third place, it is characteristic of most mountain lines to possess a considerable amount of tunnelling. The difficulty of properly ventilating tunnels, especially on single lines, where traffic perhaps runs first one way, then another, is notorious when steam locomotives are used, and time after time complaints are made of the smoke and fumes found in these tunnels, both by passengers and railway staff. All such trouble is avoided by the use of electric locomotives, and their employment on this account alone has been suggested more than once on lines where long tunnels exist.

Although the facts thus detailed may appear to have more particular interest to the engineers of countries like Germany and Switzerland, where rack railways are almost as numerous as visitors to ride upon them, there are yet many places in England, its Colonies, and dependencies where rack working is quite as possible and desirable as on the Righi or the Harz. One of the latest projects in Switzerland has, however, peculiar attractions from its very boldness, and a little attention may therefore be worth giving first of all to the proposed line up the Jungfrau—a mountain that has not, perhaps, the savage sternness of the Matterhorn, but which, for all that, is not a pleasant promenade for the amateur.

The greater part of the Jungfrau line is to be in tunnel, and therefore the use of electricity becomes almost essential if passengers are to be carried with any degree of comfort, not to say pleasure. The first mile and a half is open, and the tunnel which follows has a length of 6·2 miles. Of course the object of tunnelling is to obviate all danger from avalanches or rock falls. The grade—25 per cent., or 1 in 4—is not steeper than that of many other rack lines already operated with success, as, for instance, the Pike's Peak, Rothhorn, and Mont Salève. The last named is worked by electricity, as will doubtless be remembered; but the two former, like most of the existing rack lines, are operated by steam locomotives with combined rack and adhesion mechanisms—that is, two separate sets of cylinders and gear are provided, one to work the rack wheels, the other the adhesion wheels, though, of course, the chief work of hauling is done by the former.

The average speed proposed for the Jungfrau line is five miles per hour, but it is hardly probable that this will be attained in practice; four miles per hour ought to be the *maximum* speed attempted. A total gross train weight of 20 tons would require at the latter speed 120 h.p. to raise it over the grade above mentioned; and of the 20 tons about six tons would represent the weight of motors and gear mounted on the car and capable of giving this output. This allows nine tons for the car, which should for this weight be equal to a capacity of at least 50 passengers. It is doubtful whether the net paying load would in any case be more than about 20 per cent. of total train weight, but the difference between electrical and steam lines, in favour of the former, will be noticed at once when figures for the latter are given. Take, for example, the Rothhorn line, with equal maximum grade—viz., 1 in 4. Here the steam locomotive weighs 17½ tons and the train 8½ tons, making a total of 26 tons for a maximum net paying load of not more than about 3½ tons, equal to only 12½ per cent. of the total. The same conditions apply to other lines of this kind—*e.g.*, that at Schafberg (Austria), with engine weight of 17·3 tons, and train weight of 10 tons; the Generoso line, engine weight 15 tons, train weight 10 tons (accommodating 56 passengers); and, lastly, the Mont Revard (Aix-les-Bains), with engine weight of 17 tons and train weight 10 tons, carrying 60 passengers. All these lines have a similar grade to that proposed for the Jungfrau. The Pike's Peak line is slightly more favourable to steam traction, though still far less efficient than if operated by electricity: the engine weighs 24 tons and the train weight 19 tons, carrying 100 passengers, or a proportion of, roughly, 14 per cent. for the net live load.

As might be expected, there is ample water power available for the proposed Jungfrau line, a waterfall capable of giving at least 5,000 h.p. existing about five miles from the starting point of the line. The length of circuit out and home would therefore be nearly 23 miles. So far as the rail return circuit is concerned, the ohmic resistance for all rack lines is almost negligible, seeing that not only is the whole understructure—rails and sleepers—metallic and interconnected, but the rack itself forms an additional conductor of no small area. The distance mentioned is not too great for the use of ordinary direct currents, for although the drop of voltage must be heavy for a reasonable size of conductor, yet the source of power being so inexpensive energy can well be wasted in line resistance. The use of a "booster" dynamo at the power-house would overcome any excessive fall of pressure in the furthermost line section, involving reduced speed in the motors. At the same time, this installation if carried out should afford a very good opportunity for the partial, if not complete, use of polyphase alternating currents. Three-phase generators in the power-house would allow of a high pressure and small mains across the five miles intervening between the source of energy and feeding point of the line (just as in the case of the Dublin electric tramway), a transformer station being erected at the point connecting with the line equipped either with motor generators for direct-current working after the usual fashion, or with simple static transformers operating three-phase motors on the cars or locomotive. In the latter case, two line conductors and trolleys, or sliding contacts, are necessary, the rails forming a third conductor.

Lines of somewhat similar character, differing, however, in so far as they are almost entirely in the open, are those building or proposed for Snowdon and Ben Nevis in our own country, and in both cases there is the prospect of sufficient water power being available close at hand for working the lines if thought advisable. The financial question of the cheapest method of operation is not, however, so easily answered, and it is quite possible that the steam locomotives now employed on the Snowdon line might prove more economical on the whole than electric motorcars. The decision in each case turns on the relation between average cost of fuel and the interest with amortisation of the capital outlay upon an electric generating station and plant. In Switzerland the cost of utilising water power is not usually at all excessive, whilst briquettes are 30s. a ton in Geneva.

The proper or most suitable type of locomotive or motorcar to adopt on an electric rack line involves a subject important enough to require consideration in a separate article, and the writer hopes to deal with the matter in due course at greater length than would at any rate be now permissible. It will be sufficient here to differentiate the motive elements of rack-railway trains into two great classes, according as the lines themselves are of the "sightseeing" or "tourist" order, being merely of short length running to the top of a height; or form part of a "through" line, being then a section or branch of an important thoroughfare. In the former case, although the grades are usually much steeper (ranging up to 25 or 30 per cent.) the loads are not very great, one or two cars for 50 passengers or so being practically all the train required. The motor output is not, therefore, often higher than 100 h.p. to 150 h.p., and motors with gear, etc., to this extent can be fitted up compactly enough below the framing or between the trucks of an ordinary passenger

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car. Moreover, the deadweight of motive element is not very great, nor yet the total train weight, and therefore no particular advantage results from using the adhesion wheels for driving purposes as well as the rack pinions. Finally, each line being practically self-contained it may be wholly equipped with the rack, and thus offer no difficulties in the way of shunting or making-up trains.

Very different conditions are found to rule with the second class of rack lines. The train weights dealt with are much larger, as they form sections of main-line service, and the motive horse-powers run up to 400 and 500, although the grades usually are much less, ranging, say, from 1 in 25 to 1 in 8. In such cases it is absolutely necessary to build special electric locomotives which are fitted not only with powerful motors working the rack pinions, but have also other motors driving the adhesion wheels (preferably coupled together), so as to take full advantage of the locomotive weight and relieve the rack mechanism at least to that extent. Obviously the adhesion wheel motors are of great service in shunting and marshalling the trains when off the rack section. There are many points of great interest in the development of such locomotives, but, as already stated, they must be left for full consideration at another time.

Of this second class of line may be mentioned two typical instances from the writer's experience within the past two years, being called upon in both cases to give provisional estimates, etc., for their equipment. The first of these has a total length of 6·62 miles, with an average gradient of 1 in 22. The train loads to be hauled average 150 tons, at a speed of from six to ten miles per hour. Allowing a weight of 50 tons for the locomotive, an output of at least 675 h.p. would be required to pull the gross load of 200 tons at the higher speed; and no little care is necessary in scheming out the best method of splitting up this output amongst the various adhesion and rack motors.

The second line has points of still greater interest, seeing that it is mostly in tunnel and of much steeper grade, averaging 1 in 8. The train loads are smaller, not exceeding 70 or 80 tons, but owing to the steep grade, locomotives of almost as powerful a type would be required, weighing certainly from 30 tons upwards. At a speed of six miles an hour an output of 600 h.p. would be required for gross train loads of 120 tons on this incline.

The type of locomotive suggested for this purpose comprised two bogie trucks fitted with coupled wheels and motors for adhesion driving, carrying a centre framework for the rack motors and gear. In both cases intermediate spur gear was proposed, partly on account of the low train speed and comparatively small adhesion motor output, whilst its employment for the rack motors secures a more convenient framing. Moreover, the rack pinions themselves are merely spur gears with staggered-teeth, so that in any case the large motors would work through gearing. The use of spur gear for powerful electric locomotives would seem to run counter to good practice, as carried out on the Liverpool Overhead and South London Railways, where direct driving is employed; but that it has undoubted advantages is shown by its adoption throughout the series of large electric locomotives just designed by the Baldwin-Westinghouse combination.

WATER-POWER ELECTRIC PLANTS IN THE UNITED STATES.*

BY BUSHROD C. WASHINGTON, JUN.

For ages man has sought to overcome the vast powers of nature and so control them that they do his bidding. Human genius has gained this contest, and on the eve of the twentieth century an enlightened world gazes in wonder and admiration while Americans harness the power of their greatest rivers, convert this power into electricity and transmit it many miles to manufacturing centres.

The first application of water as a power for driving mechanical devices is supposed to have been attempted in Rome, about the time of Augustus, and during the succeeding centuries various machines have been originated for the utilisation of water power, and recent years have witnessed most rapid and wonderful progress in their development. The old waterwheels of various types gave way to turbine wheels for ordinary heads of water, and to wheels of the Pelton type for extraordinary heads. The users of water-wheels are too familiar with these two types of wheels just mentioned for me to attempt to describe them here.

The first transmission of electrical power for industrial purposes was accomplished in the year 1878, at Sermaize, not very far distant from Paris, France. The dynamos in this instance were driven by steam-engines. The application of water power for driving dynamos followed shortly after this demonstration of the practicability of the transmission of power by electricity.

Engineers bent their energies toward the development of the best machines for obtaining the largest percentage of the power at hand, and transmitting it with the smallest loss and at a reasonable cost. The result of their deep thoughts and long, tedious, and costly experiments is the utilisation of thousands of horse-power that had been wasted daily, and the building up of great manufacturing centres. There are to-day at least 300 places in the United States where water power is used for driving dynamos, and the resulting electrical energy used for light and power.

By corresponding with the manufacturers of waterwheels and electrical machinery a fairly complete list of the places in the United States where waterwheels are used for driving dynamos has been obtained, and to the electricians of these electric plants a letter was written asking them to answer certain questions embodied in a circular enclosed with the letter. They responded quite promptly, and the result is, the following questions regarding their plants have been satisfactorily answered—viz.: The types of turbines; sizes of wheels; head and fall of water; horse-power of each size wheel under this head; whether wheels are operated individually or geared together; type of governor on water-wheel; types of dynamos—arc, incandescent, or railway; dynamos driven from common shaft or independently; number arc and incandescent lamps; capacity, voltage, and amperes of incandescent and railway generators. Is there any steam plant? Are the steam and water plants coupled electrically or mechanically? Is the water power reliable the year round? Are storage batteries in use, and how? Number of miles of electric road operated.

A few declined to answer certain questions, but the majority cheerfully filled out the blanks and returned them to me; in many cases they added much useful information.

Nearly 40 per cent. of the water-power electric plants are situated in the New England States. This is accounted for in several ways: The presence of water power and absence of coal in their geological structure, the thickly-settled condition of these States, and the innate, inventive genius and business principles of the people. Then, too, their proximity to the educational and business centres of the country is an important factor not to be overlooked. Over 65 per cent. of all these plants have less than 20ft. head of water; and when we consider how many places there are having this fall or greater, it is certainly astonishing that this power is allowed to run to waste. A great many mills and factories supply their own light, and also furnish light and power to villages in which they may be situated, and even to villages at a distances.

Only a small number of plants operate the waterwheels individually, and the majority of this small number have the wheels so arranged that they can be geared together. A favourite way of developing power is by using horizontal turbines arranged in pairs. In many cases where horizontal turbines and Pelton wheels are used, the waterwheel and armature of the dynamos are on the same shaft. About 70 per cent. of the dynamos driven by waterwheels are driven from a common shaft, clearly demonstrating that this is the better method of utilising the power.

A little more than half of these plants have additional steam power. There are several reasons for this. First, the water power is not sufficient to fully meet the requirements; second, the water power is not reliable all the year round; and third, as a duplicate system in case of accident. The fact that many plants have additional steam power, and have not stated what proportion of the work is accomplished by water and steam power respectively, makes it rather a

*Abstracted from the *Electrical World*, New York.

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difficult problem to fix the amount of work chargeable to water power alone. The reader can solve a great deal of this problem by noting the work done by the plants using no additional steam power. He will find that over 3,000 arc and 100,000 incandescent lamps and 82 miles of electric railway are operated by the water-power plants alone.

Of the 124 plants under discussion, 56 use waterwheel governors and 68 do not. Of the 26 plants operating electric railways, 19 use a waterwheel governor, five do not, and two have not stated whether or not they use such a device. The fact that so many plants do not use a waterwheel governor is almost conclusive evidence that they have a very steady power, and that the dynamos are not subjected to rapid fluctuations in their load. On the other hand, where exactly opposite conditions exist, as in cases where the power is used for street railways, a quick and reliable governor is a necessity, especially where the railway has many grades and several cars are likely to ascend a grade at the same time.

The utilisation of water power for developing electricity has become a great industry in this and other countries, and the leading manufacturers of waterwheels and electrical machinery are devoting a great deal of their time and energy to the development of special machinery for this particular field.

There are a large number of very large electric plants operated by water power, and these have been fully described in the catalogues of the manufacturers who designed and built the waterwheels and dynamos used in their construction and equipment, and also in the columns of many of the best technical journals.

The installation so successfully carried out at Virginia City, Nev., however, is worthy of especial mention. A dynamo chamber, 50ft. long, 25ft. wide, and 12ft. high, was excavated out of solid porphyry at the 1,650ft. level of the Chollar Mine. The water is brought down the shaft in wrought-iron pipes, these are united at the bottom into one single pipe, from which six 6in. pipes run to the nozzle of the waterwheels provided to drive the large dynamos. Under 1,680ft. head, 800 h.p. is developed.

The use of water for generating electricity has almost revolutionised the important industry of mining. Where no large streams are available, small streams are piped together and carried down the mountain until a great head is obtained; here the electric power plant is located and the power transmitted by electricity to the mine and used for lighting it, and driving the stamp mills and hoisting machinery. In places where the location of the water power is unsuitable for a manufacturing site, the power is developed at the falls and transmitted to the point where it is required.

The large manufacturers of waterwheels and electrical machinery are always willing to aid in the development of water power by cheerfully answering questions relating to the subject, and, if need be, will send on skilled engineers to examine carefully the location of the water power and make a full report upon the result of their findings.

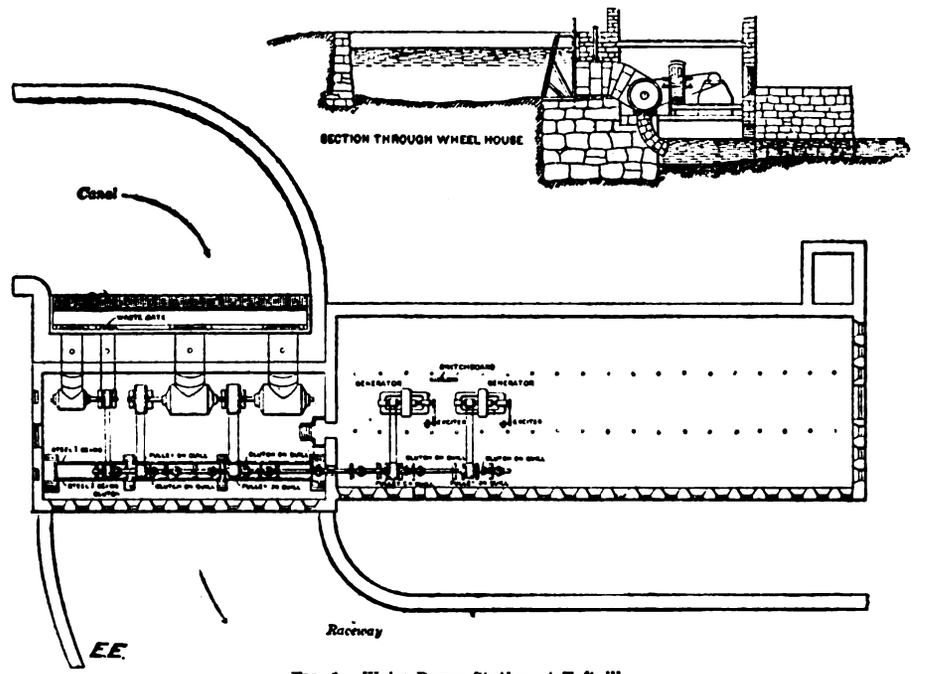

FIG. 1.—Water-Power Station at Taftville.

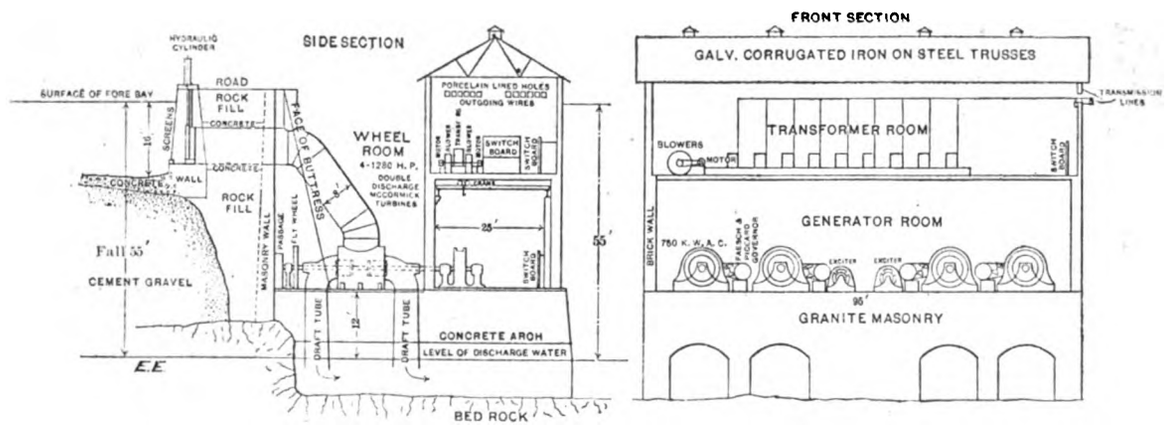

FIG. 2.—Arrangement of Sacramento Plant.

There is a very complete report on the water power of the United States in the Tenth Census report. It shows that there are hundreds of places where there is a good water power. These can be developed easily and made to pay a handsome dividend on the cost of development.

Fig. 1 is a sectional view of the water-power electric generating plant installed at Taftville, Conn. The General Electric three-phase system is here used, and the power transmitted from Baltic to Taftville, a distance of 4½ miles. Three turbines, supplied by the P. C. Holmes Company, Gardiner, Me., work under a head of 22ft.; two of the turbines develop 800 h.p. each at 157 revolutions, and

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the third 300 h.p. at 244 revolutions per minute. The belts pass obliquely upward to the pulleys on the line shaft, and the turbines are kept at speed by Schenck electric governors In the dynamo-room are two 250-kilowatt General Electric three-phase generators, delivering current to the line at 2,500 volts and running at 600 revolutions per minute. Part of the electric power thus generated is used to operate at Taftville one of the largest cotton mills in this country, the remaining power being used by the Norwich, Conn., street railway.

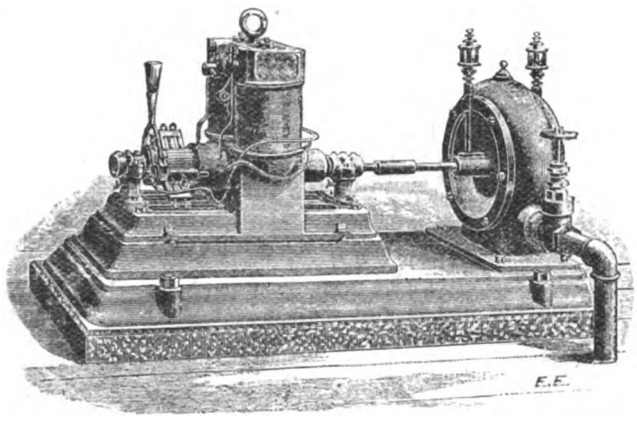

FIG. 3.—Pelton Motors Coupled direct to a Dynamo.

A plant having somewhat similar functions to the above is now being installed by the Bridge Mill Power Company, at Pawtucket, R. I. This will be of about 1,500 h.p., and will generate current for operating a street railway, for electric lighting, and for power purposes. There are five pairs of McCormick 33in. wheels, made by the Rodney Hunt Machine Company, of Orange, Mass.; these will be set 10 wheels together, in steel cylinder cases, 10ft. in diameter.

The water right is the last on the Blackstone River. The fall is about 24ft. After the river passes the dam it becomes almost immediately navigable. The power station is built upon a solid rock foundation, which has been blasted out for the purpose. The situation is exactly opposite the Goff

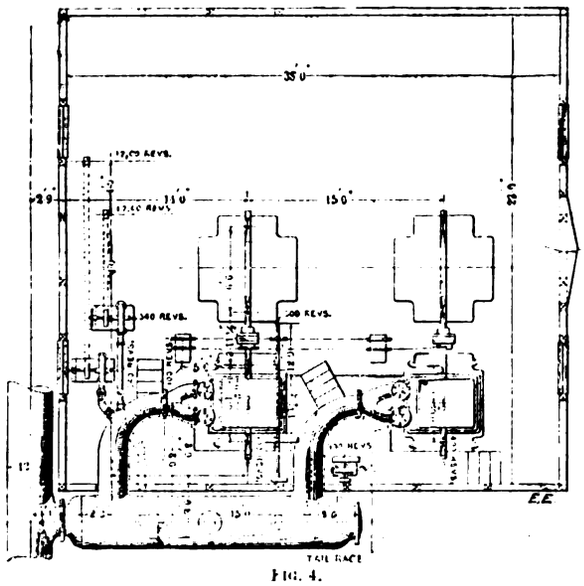

FIG. 4.

Braid Mills on the right-hand side of the river. The water enters a large brick tube and from that separates into the various penstocks for the turbines. A 500-volt direct current will probably be used.

Fig. 2 shows the arrangement of the plant of the Sacramento (Cal.) Electric Power and Light Company. There are four pairs of McCormick horizontal shaft turbine wheels supplied by the S. Morgan-Smith Company, of York, Pa., and located at Folsom. The governors are of the Faesch Piccard type, supplemented by heavy flywheels on the turbine shaft. Each pair of wheels has a capacity of 1,260 h p. at 300 revolutions per minute, and are operated under a head of 55ft. The plant also includes two special horizontal wheels for the exciters. The generators are four in number, of the General Electric three-phase alternating-current type, and furnish current at 800 volts potential. The armature shafts are direct connected to the wheel shafts by means of flexible couplings. Each generator is of 1,000 h.p., and all are located on the first floor of the building, 16ft. above the water in the tail race. In the second storey of the power-house and directly over the dynamo room are sub-station step-up transformers, in which the E.M.F. is raised to 11,000 volts for transmission from the Folsom plant to the Sacramento transformer sub-station, a distance of 22 miles. At the sub-station the voltage will be stepped down to 125, 250, 500, 1,000, and 2,000 volts respectively for lighting and motor circuits. In this station are three 300-h.p. three-phase synchronous motors directly connected to a line shaft and driving 500-volt continuous-current railway generators and a number of arc machines. At a recent test of these wheels, when a load of 800 h.p. was suddenly thrown off each pair, the governors regulated the speed of the wheels to within 3 per cent. of normal. When 25 per cent. of the load was thrown off suddenly, the governor regulated within $1\frac{3}{4}$ per cent. At present between 4,000 h.p. and 5,000 h.p. are being transmitted. The plant has been

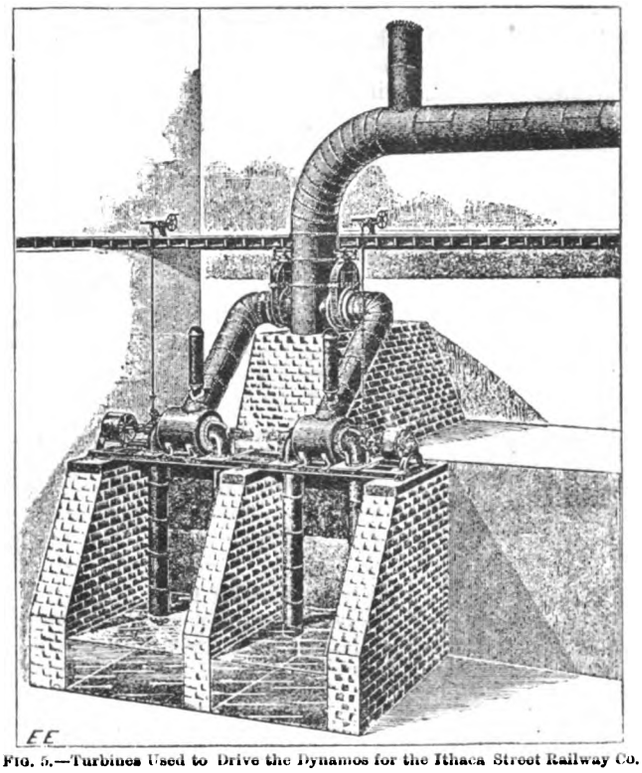

FIG. 5.—Turbines Used to Drive the Dynamos for the Ithaca Street Railway Co.

running steadily night and day since August of last year, and has proven most profitable and satisfactory in operation. All of the street-car lines of Sacramento are now run by electric power furnished by this plant.

Fig. 3 shows a Pelton motor connected direct to the shaft of a dynamo with an insulated coupling, both wheel and dynamo being mounted on a cast-iron bed-plate. This form of water motor is particularly adopted for very high heads. The motor consists merely of buckets attached to the rim of a wheel; the water is discharged into the buckets from one or more nozzles, the impulse thus imparted revolving the wheel at a rate depending upon the head. With high heads such motors can be direct connected to the dynamo, as in the case illustrated

Fig. 4 illustrates one of two pairs of Pelton wheels made for the Nevada County (Cal.) power station. The power here generated is to be transmitted to the various mines in the vicinity of Grass Valley and Nevada City, located within a radius of seven miles, and is intended for operating mills, hoists, pumps, etc. It is also intended to run a railway between towns above named. The plant is located on the South Yuba River, the flume having been arranged to carry sufficient water to increase the plant to 2,500 h.p. The wheels are of 500 h.p. capacity each, and are run under a head of 206ft. at 400 revolutions They are direct connected to two Stanley alternating-current generators of the same capacity Two separate wheels are provided for the exciters,

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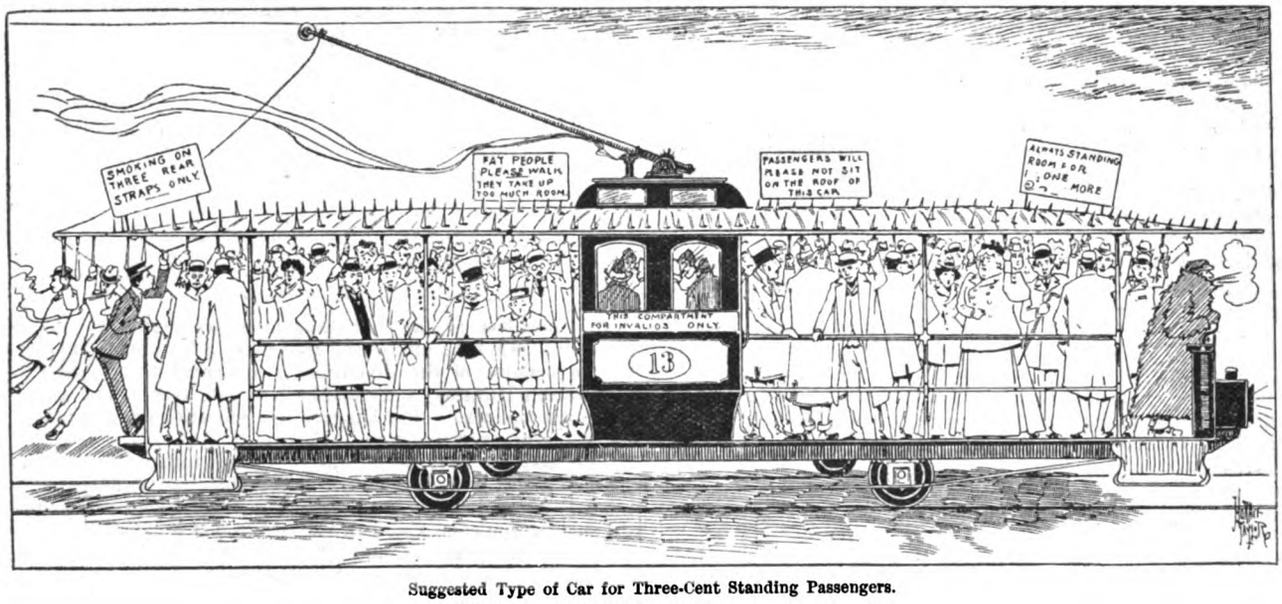
and Pelton differential governors afford the necessary regulation.

In Fig. 5 is illustrated the disposition of the turbines of the Ithaca Street Railway Company, Itchaca, N. Y. There are two 30in. horizontal wheels made by the Dayton Globe Iron-works, of Dayton, O., which operate under a 90ft. head. Each pair of wheels develops 400 effective horse-power, one furnishing power for the electric street railway and the other running electric lighting dynamos. The wheels are placed 20ft. above tail water and are supplied by a 60in. feed flume, which extends 550ft. up the stream from the power station. The generating plant was built to be run by water power when sufficient water can be obtained and a steam plant installed to assist at other times. There are two General Electric street railway generators and one alternator, one Brush alternator, two 30-light Brush arc machines, one 65-light Brush arc machine, and one 50-light Thomson-Houston arc machine The driving power is all connected to the same line of shafting to which the electrical machinery is belted.

THREE-CENT FARE FOR STANDERS.

The cartoon herewith, and for which we are indebted to the Chicago *Times-Herald*, suggests what might come if the threatened ordinance in that city should ever pass—which it will not. The ordinance calls for a three-cent fare for all passengers who are not seated, and the illustration pictures the type of car which would be needed to fill the bill.


SMOKING ON THREE REAR STRAPS ONLY
FAT PEOPLE PLEASE WALK THEY TAKE UP TOO MUCH ROOM
PASSENGERS WILL PLEASE NOT SIT ON THE ROOF OF THIS CAR
ALMOST STANDING ROOM FOR ONE MORE
THIS COMPARTMENT FOR INVALIDS ONLY
13

Suggested Type of Car for Three-Cent Standing Passengers.

THE GARNESDON PRIMARY BATTERY BOOM.

BY J. H. C. B.

(Author of "How Garnesdon Got Electricity," "Mr. Molesby's Mysterious Motor," "Peculiarities of the Electrical Profession," etc.)

When the Garnesdon world had finally settled down to an appreciation of the fact that electricity *had* come into it, and was really to be depended on, the demand for the new light became a factor of encouragement to the Electricity Supply Company and a thorn in the side of the gasworks officials. To keep pace with this demand, a mushroom growth of "electricians," "electrical engineers," and "electrical contractors" was brought about, chiefly recruited from the local plumbers, carpenters, and gasfitters, with a leaven of City and Guilds' graduates.

Oliver Buncombe first began to take an interest in Garnesdon, apart from his occasional comparisons of "price per unit generated," when he heard from a relative living near there that the town was in want of some good wiremen. The relative stated that the "practical men" who fitted up houses for electrical illumination were charging excessively high prices, and that much of the installation work was based upon an evident belief in the insulating properties of moisture, and conceived with original ideas regarding the current capacity of copper wire.

The hint was sufficient for Buncombe. Having spent most of his time either in the comfortless laboratory at Leonard-street or in the Patent Office library, he had no particular ties of a social character to break, wherefore he bade his parents *au revoir* and went to Garnesdon, strong in the hope of his relative's introductions, and determined to show what Thompsonian teaching could bring forth.

He had not long to wait. Scarcely had his modestly-worded circular letter been the rounds of the compulsory area, when his relative sent him the names of two people who wished their houses installed. Buncombe submitted an estimate based upon 30s. per light, and was agreeably surprised to find them accepted in both cases. He had done little odd bits of wiring at times, and learnt from books and the anecdotal experiences of friends in the trade, but he had never had a 25-light job before, and in his calmer moments he felt a trifle uneasy about the result. His education had been such that he could have designed a multiphase dynamo, or tested the "funniest thing" in cable faults with a greater amount of confidence than he had in his ability to get leads through ceilings, brick walls, and other ghastly obstructions which the legends of his friends had credited with defying braces, cold chisels, and the efforts of contorted and perspiring wiremen.

However, the Fates were kind, and the houses chiefly wainscotted, so Buncombe pulled through with the help of an out-of-work plumber, and by putting in good material and conscientious workmanship he got testimonials which stood him in good stead in obtaining further orders.

One eventful day he had to work overtime on an installation that was wanted particularly by a certain date—the twenty-first birthday of the daughter of the house—when an "At Home" was being given by the young lady's mother, Mrs. Bright. Buncombe had been on the job all day from early morn to dewy eve, and was by no means confident of having his work finished in time for the following evening's festivities. This uncomfortable feeling was increased by the fact of his man's pension falling due on the previous day, and consequently he had come along too drunk to do a stroke, and would probably be worse than useless until he had got rid of his superfluous cash in company with his old comrades-in-arms; so Buncombe gave him the temporary sack.

By night Buncombe had got everything put up—primitively, it is true—and after turning all the branch switches on he closed the main switch and went through the house to admire the effect. On entering the drawing-room, however, he found all in darkness, and then he remembered that his wireman had started work in the room that morning before being told to go. He went to the door switch, and, unscrewing the cover, saw by the light of his match a blackened base and the two ends of a fuse. This explained the matter; the fuse put in had been too small, and as a natural consequence had burnt out on the current coming on.

Buncombe felt much annoyed at the man's stupidity, and recollecting that the rest of the fuse wire was stowed away at the bottom of his tool-chest, the effect upon his already over-anxious mind was such that he said what he thought about the culprit in a spiteful undertone and with little circumlocution or delicacy of expression. It was in the middle of a particularly *recherché* passage that a slight movement in the room caught his ear and, staying his tongue in its five-finger exercise, he looked

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around and saw that Miss Bright was lying on the couch with both hands to her ears and a shocked expression on her face. She was looking directly at him, so Buncombe, with the flame of the match approaching perilously near to his finger tips, lowered his head in abject sorrow, and, in his most contrite manner, begged her pardon, mentioning that he did not know anyone was in the room.

"Is that any reason why a man should so degrade himself?" asked Miss Bright, severely, taking her hands from her ears, and sitting up.

"None at all," faltered the unhappy Buncombe. "I can only say that it shall never occur again."

The very next thing he said, however, quite gave his assertion the lie, for the match had burnt under this thumb-nail, and the sudden agony bereft him of what remnant of reason he had left.

Before the echoes of the semi-scriptural exclamation died away, Miss Bright had hurriedly sprung to her feet and brushed past him out of the room, and Buncombe, when he was sufficiently recovered to do justice to the occasion, shut the door and had a soul-satisfying five minutes with the best authors, after which, feeling better—as men do when they have relieved themselves of an overload of spontaneously generated profanity—he wedged a penny between the fuse terminals, and had the satisfaction of seeing the lamps become incandescent.

Early the next morning he got to work, and was putting the finishing touches to the hall fittings, when dainty footsteps on the stairs made him instinctively aware that the shocked fair one of the previous night was coming down to breakfast, and the spirit moved him to wish her "Good morning, and many happy returns of the day."

"I hope you mean none of last night," said the girl, hitting the nail on the head, and there being no one about she dropped her voice, and said more seriously, "It was very sad to hear such a young man speak so irreverently."

Buncombe could not help smiling; he was not used to being called a young man by anyone under middle age.

"And I'm sorry to find that you treat the matter so lightly," she continued, and was moving away with an air of offended dignity, when Buncombe recovered his gravity and the sense of the situation, and explained that he had meant no irreverence, but had been very much upset the night before to find that the electric light might not be ready in time for the "At home."

"Will it be quite ready now?" asked Miss Bright, when he had finished his apologia.

"Yes, unless my man has done any more bungling that I have not discovered."

"In which case I hope you will control yourself rather better than you did last evening." And she disappeared through the morning-room door.

Buncombe managed to get through his work that day without serious mishap, though he did try to connect lamps to acorn pushes, and attempted to use screw-drivers on hexagons occasionally. This, as an effect of overproof penitence, was to be excused, and he divided his leisure thoughts between comparing himself to loathly things and dwelling on the inflections of her voice and grace of manner. And in course of thought, his personal conceit being brought to bear upon the subject, it struck him that he had been a very lucky fellow in getting off so easily, and that perhaps, on the whole, he had done a very good thing for himself. The girl's face was not strictly beautiful, judged from Roman or Grecian or Etruscan vase standpoints, but it was a clever face and interesting, while her manner charmed him. With almost a woman's instinct he found himself surveying his working clothes with a degree of false shame that he was unused to. This sign alone would have told an observer (in terms as clear as a trade consulting electrical engineer specifies patented machinery for public tender) that Buncombe had found his divinity. Whether he was successful in obtaining his contract for maintenance of same it is the purpose of this history to discover.

* * * * * *

Several moons had measured their photometric qualities against the Garnesdon arc lamps since Oliver Buncombe first met Frances Bright, and having discovered that his relative knew the Bright family, his acquaintanceship with her had gradually ripened since the first inauspicious *rencontre*, until now he was her greatest masculine friend. This coveted distinction, however, was no sinecure, there being several competitors ready to undercut him, and the favourite of the second string was also in the electrical line, being a manufacturer of small dynamos, motors, batteries, and general fittings, in addition to which he did installation work.

Thus Oliver Buncombe and he, David Chilcote-Huntley, A.I.E.E., were often co-tenderers for contracts, but the principal cause of rivalry existed in another and, it may be added, a tenderer direction.

And so it came to pass that when Buncombe one day read a certain paragraph in the "local rag" he was sore dismayed, for Miss Bright had a weakness for genius, and the most flattering thing she could tell anyone was, "How clever you are!" Huntley had considerably risen in her esteem since he had added the slightly fanciful initials "A.M.I.E.E." to his name, and now Buncombe feared for the worst if the paragraph was bolted to the concrete foundations of fact.

The paragraph ran as follows:

REVOLUTION IN ELECTRICAL SCIENCE!—*Garnesdon Leads the Van of Progress*!!—It has been our lot during this newspaper's existence to chronicle many wonderful local occurrences, but the subject upon which we now write is, we feel sure, destined to overshadow all previous happenings in our pretty little town, and will eventually make Garnesdon an honoured name in the history of electrical invention. It may not be generally known, owing to the modesty of the gentleman himself, that our esteemed fellow-townsman, Mr. D. Chilcote-Huntley, A.M.I.E.E., has been making elaborate experiments during the last few years on primary batteries. These experiments have now culminated in a discovery which is destined to *revolutionise electrical science*!! We do not make these statements rashly, for we have been favoured with a special invitation to test and report upon the result of Mr. Chilcote-Huntley's labours. At the time of our visit we found him deeply engaged in abstruse calculations at his desk, surrounded by works upon electricity, chemistry, etc., and after showing us passages in these, declaring that two volts was the utmost current obtainable from a single battery, he connected the cords of a measuring instrument to one of his own special batteries, and proved that the electric motive force moved at the rate of three volts per second. The instrument we were assured was correct, and Mr. Huntley showed us a report from an eminent consulting electrician to whom he had sent one of his batteries for testing purposes, which stated that "the cell maintains a fairly constant E.N.F. of three volts, with an internal resistance of 2·10364 ohms." The battery has, of course, a commercial as well as a scientific side, and we beg to draw our readers' attentions to our advertising columns for further particulars.

With a sinking heart, that even the light side of newspaper science could not entirely arrest, Buncombe scanned the advertisement pages, when the following caught his eye:

THE MOST POWERFUL PRIMARY BATTERY IN THE WORLD.

A Three-Volt Cell!!!

Can charge accumulators at small cost. Is suitable for all kinds of work. No need for machinery for country-house plants. No dirt, no smells, no oil. Maintenance guaranteed smaller than any other make. Can always be recharged and does not deteriorate. Send trade card for price list and full particulars to

D. CHILCOTE-HUNTLEY AND CO., 13, Chester-road, Garnesdon.

Works: Rake-lane, Garnesdon.

Agents Wanted.

It is needless to say that Buncombe felt very sick; he felt sicker still when he discovered that most of his clients, attracted by the glamour of the invention, transferred their custom to the Maison-Huntley, and that the bulk of fresh trade went in that direction also. But the sickliest sensations were provoked by the green-eyed monster.

This may not have been quite necessary, but, to do Buncombe justice, it was perfectly natural under the circumstances. Few men have philosophy and sense of discernment enough to distinguish between a woman's admiration of an abstract quality and the deeper feeling, and the more blind in this respect are they who play the game. So that when Buncombe had to listen to his divinity's eulogies of the battery inventor; when he noticed the glances of respectful admiration that she bestowed upon his rival; and last, but not least, when his business slackened to the very verge of holiday-making, while the other man was working overtime regularly, he began to consider the advisability of inventing something if only in self-defence.

What it was to be Buncombe himself did not know. Being no chemist, he at first disdained the idea of batteries and processes, and dwelt upon the nobler flights of perfecting either dynamos, transformers, meters, etc., or if the worst came to the worst he would invent a switch. With this end in view he sought his friend Barker, the electrician at the electricity works, and in course of conversation endeavoured to discover what portion of the plant wanted perfecting most.

Barker, however, appeared quite satisfied with the original design of the station machinery and apparatus, and could only suggest improving the greasers and improvers into habits of discipline, sobriety, and ordinary carefulness, for it was well known that Holloway, the engineer, had a hot handful of a staff.

"Nothing on the mains even that wants furbishing up?" enquired Buncombe. "No fancy switching arrangements for regulating varying loads or connecting street arcs?"

But Barker was confident that everything was in satisfactory order, and it is improbable that he would have given any intimation otherwise in any case to a fellow electrician, for palpable reasons.

So Buncombe returned to his establishment with the fixed resolve of clutching at the straw of switch invention. But the possibilities of distinction in this branch of discovery soon disappeared when he surveyed his varied stock of *interrupteurs*. As he observed in a moment of lax-tongued despair, "Every blooming way of doing every blooming thing is already too blooming well done." That night he dreamed of inventing a

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perpetual polyphase motor, with fields excited by the earth's magnetism, and, on waking, went to work with fierce energy to devise the best means of applying terrestrial magnetic lines to dynamic machinery.

Buncombe has not yet perfected his arrangements in this department of applied science.

* * * * * *

Oliver Buncombe never knew exactly how or when the magnificent idea occurred to him, but to this hour he attributes its happy advent to the special interposition of Providence. This view is perhaps somewhat weakened by the fact that Buncombe, in his installation work at least, had never trusted much to Providence, and therefore it is fair to assume that it would hardly be likely to shower favours upon him. However, the idea came, it took root, and finally it blossomed, and the invention of a perfectly astounding primary battery—once the despised and rejected road to fame—was the outcome of the thought.

And so it came to pass that the following article in the *Garnesdon Observer* shook the electrical section of the town to its base-plates, and the local "A.M.I.E.E." knit his learned brow with righteous wrath and astonishment when his mind had grasped the fact that his rival in love and competitor in trade had trumped his ace:

GARNESDON MOUNTS THE LADDER OF FAME ON THE WINGS OF PRIMARY BATTERIES.

Yet another local Edison!

When we noted in our issue of the 23rd ultimo (copies of which can still be obtained) that an invention of the first importance in the electrical world was due to the ingenuity of our fellow-townsman, Mr. D. Chilcote-Huntley, A.M.I.E.E., we little thought that within the boundaries of our town another mind was occupied in the same work of making two blades of grass grow where but one had grown before, and that the millennium of electrical service was being hastened through the same channel of discovery.

To be brief, the latest inventor among us is Mr. Oliver Buncombe, Cert. Honours, Finsbury Technical College, who since he came here, barely six months ago, has been responsible for the efficient fitting up for the electric light of a great many of the better-class houses in Garnesdon. When, in response to his invitation, we called upon Mr. Buncombe, he told us that his experiments in the direction of a perfect electrolite had been the dream of his life, but that until very recently, spurred on perhaps by the success of his friend Mr. Huntley, he had almost given up hopes of realising this ambition. At last, however, he has succeeded in producing a battery which gives no less than 5·47 volts with an internal resistance of but ·65 ohm. This, we need hardly say, out-Herods himself in the shape of Mr. Huntley's remarkable discovery.

It might be reasonably imagined that this result would reach the limit of electric battery power, but Mr. Buncombe is sanguine of his ability to still further improve in this direction, and therefore, while allowing every facility for testing his cells, they will not be manufactured commercially until he is sure of no further improvement being possible in the electrolite.

We may say that we have seen the battery tested, and are satisfied of the *bonâ fides* of these statements, and we shall chronicle with interest further developments of this wonderful invention.

It was now Huntley's turn to become sick, for he, too, had observed the little weakness for genius in Miss Bright's mind, and he had also been misinterpreting the

"Becks and nods and wreathéd smiles";

for such was the natural charm of her manner that an impressionable man might be forgiven for taking things rather for granted. He had noticed, also, the additional interest she had favoured him with since his own invention appeared in print, and though he would not confess openly to himself that Buncombe's invention would make any difference to him in that quarter, he instinctively felt that it would be very much more satisfactory for himself if Buncombe and Buncombe's battery were in permanent residence in Hades.

As for Buncombe himself, he would hardly have changed places with the P.F.R.S., so consistently joyful did he feel. Not altogether on account of the intrinsic value of his cell, for he had reasons for supposing that, whatever its virtues from a scientific point of view, it would hardly be the commercial success that the "local rag" anticipated. Still, it would be the means of restoring his prestige in the eyes of his inamorata, and it would bring grist to his mill. It was well known that on account of its high price the Huntley cell did not sell well, but that its fame brought its inventor customers for other goods. In like manner Buncombe hoped to reap success, and already looked forward to an extension of premises and an augmentation of staff.

Then the question arose in his mind as to what he should call the cell. Should it deliver his own name to an unending immortality as the "Buncombe cell," or should it receive a classical or fancy name, emphasising its power and long life, such as the "Sandow" or "Methusaleh"? The former course Buncombe's modesty protested against, and the latter seemed more fitting for incandescent lamp designation or gas-engine nomenclature. Or, since he might have to form a company to exploit it and furnish capital for an enlarged sphere of operations, would it not be best to follow the prevailing fashion in battery-naming and call it by the initials of the company's title, such as the G(arnesdon) P(rimary) B(attery)? Eventually, however, he decided in the fulness of his heart, and in utter defiance of all the canons of electrical battery appellation, to call the cell the "Frances"; and with regard to the prospective company that would be formed on the strength of its good name, he mentally drew up an advertisement for the electrical magazines replete with short, crisp, competitor-defying phrases in various sizes of block lettering, with illustrations and text fearfully and wonderfully arranged to catch the eye, and he finally dropped off to sleep that night endeavouring to decide on a suitable telegraphic address that would indicate forcibly the supreme worth of the company's work and goods, and yet be a word easy of remembrance by the busy contractor.

And all next day he thought of the possibilities the thing opened up, the attainment of A.I.E.E., and the gradual transition to M.I.E.E., the suite of electrically-lit offices in that hotbed of electrical engineering, Westminster, the admiring reception that should be accorded to his paper delivered before *the* Institution on "Some Recent Abnormal Developments in Electrical Primary Cells," and the charms of the discussion that should follow, in which every professor present would compliment him fulsomely upon his invention and would each casually mention his own previous discovery of its principles. The latter reflections, however, seemed to amuse Buncombe more than was absolutely necessary, and he enjoyed the effects of his imagination still more when contemplating the technical magazines' probable reports of his paper, with white discharge diagrams printed on a black ground, which would make a fearful mess on the fingers of the readers of the *Electrical Laroo*, whose printers' ink took months to dry. And joyful visions of an earthly paradise replete with domestic bliss filled his mind, until in looking over his *Electrical Buccaneer* of the current week he found that part of the *Garnesdon Observer's* article relating to his cell had been reproduced, and that the following editorial comment was appended:

The above is submitted as a sample of provincial newspaperese. We hardly think it worth dealing with otherwise, as the veriest tyro in electrical knowledge will be aware of the absurdity of its statements, which is about on a par with its knowledge of technical spelling. What manner of man this Mr. Oliver Buncombe may be, who has inspired the guileless provincial editor with his abormal abilities, is a puzzle, inasmuch as he appears to have done a certain amount of installation work with credit. Whether he has deceived himself over this cell (or sell) more than the editor of the Garnesdon paper is not of our knowing, but we charitably hope, for the sake of Mr. Buncombe's reputation, that the figures given are misprints, and that the literary matter is the self-inspired drivel of the mechanical newspaper scribe.

Buncombe read this through without turning a hair. He might have expected it, so unconcerned was he over the sloshing of "his life's dream."

"Oho!" he murmured pleasantly; "so the press-clippings people have got hold of the *Observer*. I wonder what the other papers have to say about it"; and he went out and borrowed the other electrical magazines from different people, it not being fashionable to take in more than one of the technical papers at a time in the provinces, and they are not readily obtainable at bookshops or station bookstalls.

The *Electrical Laroo* was one gigantic advertisement of a newly-opened central station that week, with a description replete with adjectives of superior quality concerning every trivial detail of machinery in connection with the station, and what space it had to spare was occupied by correspondence upon one of its ably worked-up controversies, so that it had evidently no room for baiting such regular quarry as battery inventors.

The *Electric Ion* being somewhat empty on account of its universally interesting serial article by Roland Ditchwater having to be delayed that week, on account of the printers running out of Greek and Arabic type, had found room for a leaderette paragraph, which commenced with an aphorism, was interlarded with quotations, and concluded by appealing to the gallery with the statement that "Cells which depend upon special chemical processes for their successful working are, in more senses than one, *drugs* in the market."

Electricality also had a note at the end of its "Chatterbox" columns, which, after quoting from the *Observer*, said: "It is amusing to observe at what regular periods the primary battery inventor makes his preliminary flourish of trumpets through the untechnical Press, and how similarly ridiculous are the advantages claimed for each new type of cell. One source of comfort, however, for the perpetually threatened engine and dynamo manufacturers lies in the uniformity of nothingness to which these enterprises come. Whether or not the promoters of such absurd ventures are more fools than knaves is often a subject for conjecture with EXPECTRONG."

Fizzling did not mention the matter at all, and Buncombe surmised that it was sitting on the fence waiting to see what the *Buccaneer* and *Laroo* said, so that it could be sure of either taking an opposite view or could split hairs over the former's grammar and point out errors in the latter's classical quota-

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tions, which were its chief functions in its capacity as court fool to the profession.

Buncombe had just finished reading these encouraging expressions of opinion, and was congratulating himself that Garnesdon as a whole was not likely to see them, when Mr. Huntley was announced. The two men eyed one another keenly while shaking hands, and the visitor said :

"There's a strange article in the *Observer* about a miraculous cell which it says you have invented. As you know, I am interested in that kind of thing, and I have called to see if there is any truth in the report."

"The account is perfectly true," replied Buncombe. "Of course, you will understand that I did not supply the high-falutin' part of it, or the execrable technicalities, any more than I presume you did in your cell's description ; but the figures are right enough, and that is the principal thing."

"Well, you'll excuse me, I hope," exclaimed Huntley, "but it seemed to me to be perfectly absurd—most awful rot, in fact, and I have not met anyone who knows anything about cells who believes a word in it.

"You are all welcome to your opinions. I hope to have a public demonstration shortly, and then you can see for yourselves. In the meantime, perhaps you would like to see the article in question ?"

Huntley jumped at the offer, but was not so pleased upon being told that he was not to touch the cell.

"You will understand that my process is so simple that, until I can protect it legally, I must be careful," Buncombe had said.

So Huntley passed his society affidavit not to do any undue investigating, and followed his host into the back room, where, illuminated by a dim, religious light from some dingy back yard windows, the bulky form of a glorified Leclanché-looking cell was apparent on a table. The testing instruments lay near, and some rival trade catalogues, with a broken carbon block or two, gave a realistic picture of an "electrical contractor's" lab.

Buncombe had the connections ready between his cell and the apparatus, and Huntley saw that the reading on the galvo. was over five volts by comparison with the standard cell deflection. Then Buncombe brought the Wheatstone into play, and showed the resistance to be the simple demi-ohm he claimed. Very little was said by both men ; the one keenly critical and noting every detail of the cell, the other seemingly absorbed in admiration of his own work, but never turning his back upon the visitor for a moment.

"Is there anything else I can show you ?" said Buncombe at last, noticing that Huntley was looking about the room as if in search of something.

"No, thanks," answered Huntley, bringing his eyes back with a jerk to the subject of conversation. "I suppose you would not care to lend me the cell for a day or two ? I think I have more facilities for experimenting than you seem to possess, and if I discover any improvements on it you can rest assured of your share in the profits."

"Much obliged," smiled Buncombe ; "but I guess I can finish the thing off now, after getting on so far with it," and he moved towards the door.

But Huntley did not take the hint. His eyes were again wandering over the room, and presently he said, in an absent-minded way :

"You haven't seen any of my cells yet, I suppose ?"

"No," answered Buncombe, playing with the handle of the door.

"Well, I wonder if you have gone on the same lines as myself," continued Huntley. "I hit on peroxide of lead in contact with platinum, having zinc and sulphuric acid outside the porous pot, and then I found lead would do just as well as platinum for the positive pole. This combination was successful enough to make me want to get more out of it, so I tried oxalic acid and obtained an E.M.F. of 2½ volts with an internal resistance of only half an ohm, and the voltage hardly dropped at all after two days' work !"

"Oh !" said Buncombe, feeling that all this was only intended to draw him into an exchange of confidences.

"Yes, 2½ volts right off the reel, and even then I was not satisfied ; but what do you think gave me the three volts I was after ?"

Buncombe scratched his head gracefully, in seeming meditation upon the question.

"Why, caustic potash," Huntley went on ; "only the resistance went up because another porous pot was used. And the price went up, too, unfortunately. Now, I wonder what you can sell your make at—the gross, I mean ?"

But Buncombe did not reciprocate, so Huntley, after unsuccessfully suggesting mutual refreshment (which among business men is the usual preliminary to making something out of one's guest), left the place with nothing satisfactory for his pains.

Buncombe went back to his lab., and investigated a window that Huntley had been scrutinising intently during his discourse. There was nothing very attractive about it, even if it had been a clean window, which it was not. It, however, opened directly into a blind alley leading from the main thoroughfare, and Buncombe noticed that the bolt was unfastened. He had put it under its clip, and then a thought struck him, and he unfastened it again. This was a strange thing to do, but some other actions of Buncombe's were more mysterious even than that.

He went to the bench, put his hand down into the cell and unscrewed some things at the bottom of the elements which looked suspiciously like terminal nuts, though why the cell should require electrical connections at the business ends of its electrodes will for ever remain an insoluble mystery. He then disconnected some attachments from the bottom of the cell, and carried it into his private office. Returning, he pulled a Daniell battery from under the bench to another part of the room, together with some rubber-covered wires that were now to be seen projecting through the bench, like dining-table lamp fittings.

After which he brought a glazed porcelain cell of the same size as the one he had taken away, and put in it elements of the same nature as contained in the original. To all appearance the cells were identical, and Buncombe filled the pot with insulating oil, which in the dim light completed the resemblance. His next step was to select one of his stock of transformers, which were used on the Garnesdon high-tension circuits, and to attach its low-tension terminals to the main switch of his establishment and the high-tension side to the poles of his mock battery, the latter's connecting wires leading from the direction of the testing instruments.

Then he went to bed, but not to sleep.

* * * * * *

The gas company's officials were as near chuckling with delight as ever they had been since the Garnesdon Electricity Supply Company, Limited, commenced operations, for an ill wind had blown that appeared likely to waft them a certain amount of good. That is to say, another death from electricity which had just occurred in the town would inspire people, they hoped, with distrust for the new illuminating power, which killed in a more mysterious and therefore less agreeable way than a materialistic gas explosion. And, as if to point the moral more suggestively, the victim this time was an eminent local electrician, who had gone out under circumstances which did him no credit.

The "local rag" explained the matter in six columns, but the leaderette upon the subject was more succinct and bears quoting here :

ANOTHER VICTIM TO ELECTRA.

Elsewhere we deal more particularly with the horrible fate of D. C. Huntley, of Chester-road, whose tragic end has caused widespread consternation and sympathy. Whether this latter feeling is altogether deserved remains to be dealt with at the inquest, but at present the evidence tends to show that the unfortunate man met his doom, not only through his own carelessness, but by his own criminality. It is not well to speak harshly of the dead, but facts are facts, and it is a newspaper's province to relate them. It will be remembered that deceased invented an electric battery, which was reported upon in these columns as the most powerful one of its kind, and a week or two later Mr. Buncombe also invented a battery which was much superior to the invention of the deceased. This would appear to have unhinged the latter's mind, for he was discovered in Mr. Buncombe's private laboratory early on Wednesday morning dead from contact with some apparatus that Mr. Buncombe had been testing with high-pressure currents. An open window had evidently been his mode of ingress, and it is easy to see that he came during the night to discover the secret components of the battery which had eclipsed his own. Mr. Buncombe, who was greatly shocked and grieved by the sad occurrence, states that the apparatus in question was roughly put up to determine the insulating properties of a certain kind of oil, and that the deceased must have mistaken it for the new cell, and putting his hands on the poles completed the electrical circuit, with the result that he received 2,000 volts through his body. This makes the third death in Garnesdon from electricity ; but it is as well to remember that all of them have been brought about by the worse than heedlessness of the unfortunates themselves.

On a certain day very early in the morning a quiet little wedding was celebrated at Garnesdon Parish Church, and the bridegroom was spoken of with respect as the busiest electrical contractor in the town, and the inventor of the wonderful "Frances" cell. The bride's christian name, singularly enough, was Frances also, and it is to be hoped that their wedded happiness will last until that period of revolution in the electrical industry when (*vide* the inventor's special circular) "the few final details of improvement having been decided upon and legally protected, the cell will be subjected to a public demonstration which will prove its immense superiority over any other type of cell for HIGH POTENTIAL, CONSTANT CURRENT, LOW RESISTANCE, MINIMUM OF ATTENTION, AND CHEAPNESS BOTH IN FIRST COST AND UPKEEP."

Naval.—The cruisers "Barham" and "Bellona," attached to the Channel Squadron, are to be paid off, so that each may have a thorough refit. Both will be fitted with complete sets of water-tube boilers, and also with new electric light machinery. Upon each nearly £30,000 is to be spent.

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THE INSTITUTION BALANCE-SHEET.

The balance-sheet of the Institution of Electrical Engineers for the year ending December 31, 1895, was despatched to the members about a fortnight ago. As will be seen in another column, the presentation of the sheet for approval at the last meeting of the Institution was made the occasion of another display of the friction recently developed between a few members and the Council. As will be remembered by our readers, the annual meeting held last December was devoted to a debate as useless and nearly as personal as that of an average London vestry. Although the subject opened for discussion was one which could have been discussed to advantage, the whole evening was practically wasted, as no vote could be taken. Afterwards, the question was evidently not considered sufficiently practical by its originators to warrant calling a special meeting, as was suggested by the then president. The waste of time begun at this meeting was continued until the new president wisely curbed the verbosity of the debaters. Members had become so used to enlarging on their personal experiences, rather than giving useful conclusions from them, that most of the speakers exceeded the time limit, and many the patience of their hearers. On Thursday week the subject forming the bone of contention was one of the utmost importance to everyone present. We endorse the opinion of the mover of the amendment, that "an absolutely sound balance-sheet is the greatest security that the Institution could have for the safe transmission of its funds to future generations." The question as to whether the building fund was defrauded of ninety pounds due as interest is one on which the evidence of the three eminent accountants would have been worth hearing. If the building fund is looked upon as a reserve fund, the interest should certainly go to swell the general account, as has been done. The fact that this reserve fund is eventually intended to be used for building purposes is as yet unacknowledged, as far as we know, by charter or by articles of association. So, arguing from the usual practice of limited liability companies, this reserve fund stands at a constant figure, unless increments are added after a prosperous year's working. The other points raised were all points of detail which could be readily explained by anyone reading the accounts. The main facts of the case are these. We were assured that three eminent accountants and one eminent engineer had carefully examined the accounts, and had found them absolutely correct. This statement came on early in the evening, and we all waited for the "juice" promised by the speaker in an ill-judged letter to a contemporary. We certainly got a lot of illustrations as to the use of oyster beds, the cost of wall diagrams, and the unlimited time at the speaker's disposal; but we should much like to know if the real juice was not the wish to pass a vote of censure on the honorary treasurer? After posing as a martyr because the president objected to the time of some two hundred and fifty members being wasted, it was moved and seconded that the balance-sheet be referred back to the Council for amendment. The only useful point

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brought out by the accountant in reply was that an increment in the value of the books, etc., was due to the gifts of various members. The vote then taken showed twenty-seven in favour of the amendment and seventeen against. In other words, out of two hundred and fifty members only forty-four cared enough about the subject to hold up their hands either way. This would hardly have been the case had the funds of the Institution been in peril. Of the composition of the majority, the less said the better. We would emphatically state that the want of detail in the accounts could have been clearly explained in five minutes, and that the course taken was in no wise justified by the evidence brought forward.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE REDUCTION OF LIGHT-LOAD LOSSES IN ALTERNATING STATIONS.

SIR,—Would not accumulators help us in such a station nearly as much as they have continuous-current stations? It appears to me that there would be no practical difficulty in applying them. Take an ordinary drum or ring wound armature, and at two points on the winding, 180deg. apart, take a connection to each of two rings. If the armature is then set revolving in a magnetic field by a continuous current passed through the windings and through the usual commutator, an alternating current will then be delivered on the rings having a period depending on the number of poles and on the number of revolutions per minute. For example, let the armature revolve in a four-pole field at a speed of 1,500 revolutions per minute; then if the continuous current supplied is at 100 volts, an alternating current will be delivered on the rings at a pressure of about 70 volts and having a 50 ⁓. In this case the rings will be connected to the armature windings at points 90deg. apart.

For the purpose of regulating the pressure developed on the continuous side of the machine when charging accumulators, the secondary of the alternating transformer which would be interposed between the rectifier and the 'bus bars would have a number of connections taken off to a segment switch in a similar manner to the terminal cells of an accumulator; the alternating volts supplied to the rectifier being thus varied, the pressure on the continuous side must necessarily also vary. The alternating transformer would also serve as a "step-up" when running the circuits off the cells, and in this case the segment switch would serve to roughly regulate the volts on the 'bus bars. The machine might be run up to synchronous speed when started on a nearly exhausted battery prior to switching-on the alternating current by suitably weakening the field, and the same method of regulating the speed would also serve as a "fine adjustment" of the 'bus-bar pressure when running the circuits off the battery. The same type of machine might be used for feeding electric tramways from alternating circuits.

Further, if in our four-pole machine we connect two other rings at 45deg. and 135deg. respectively, would not these rings deliver a current in quadrature to the other two rings at 0deg. and 90deg., and our single-phase current be thereby split up into a two-phase system?

There are obviously many possible applications for such a system, but it is needless to further encroach on your space to describe them in detail.—Yours, etc.,

GEO. T. PARDOE.

81, Harrow-road, W., March 30, 1896.

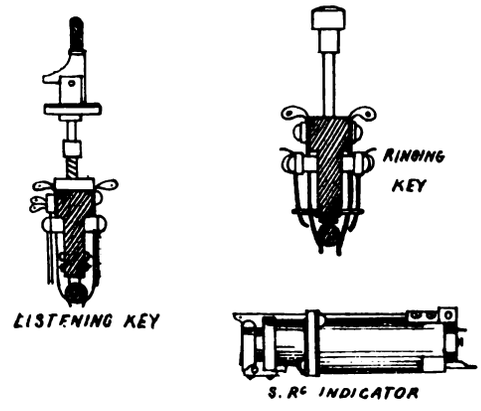
Messrs. Crompton and Co.—We learn that this firm have not yet been able to procure a site for their proposed new works. Land at Bedford, Colchester, and Ipswich has lately been offered, but the new site of the works is at present uncertain.

TELEPHONE EXCHANGES AND THEIR WORKING.*

BY DANE SINCLAIR, MEMBER.

(Continued from page 349.)

In an exchange of 5,000 subscribers, forming part of a system similar to that existing in London, there would be 1,000 junction wires—say, 500 outgoing and 500 incoming. The latter would necessitate the provision of five extra sections, thus bringing the total to 30 sections, whilst the former would involve the use of 500 additional jacks on each section, making the total number of jacks 165,000. It will thus be seen that a multiple board for 5,000 subscribers' lines is a huge electrical equipment. The number of soldered joints on such a switchboard, in connection with the jacks alone, is nearly a million, and the total length of wire is between 1,500 and 1,600 miles.



FIGS. 3, 3A, AND 5A.

The largest switchboard we have in this country is one which has been provided for taking the total number of jacks required for 8,400 subscribers' lines—*i.e.*, including junctions, 9,000 line jacks on each section—and for such an exchange, fitted on the ordinary multiple system, there would be required a total of 432,000 line jacks; so that, while we have only increased the number of subscribers' lines from 5,000 to 8,400—*i.e.*, 68 per cent.—we have increase the number of multiple jacks required from 165,000 to 432,000, or 162 per cent.

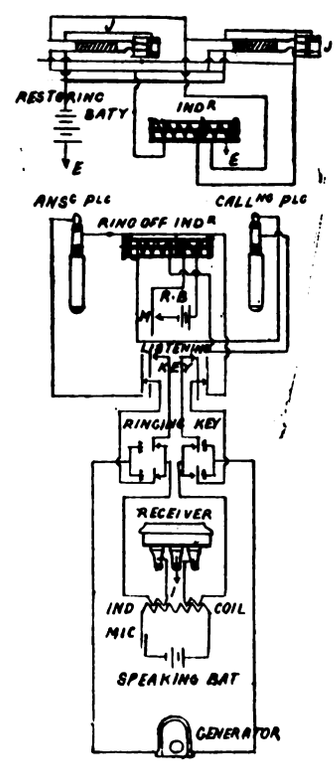


FIG. 4.—Diagram of Branching System with Self-restoring Indicator.

In Fig. 5, A, B, C represent a subscriber's line passing through separate sections of a switchboard. The wires come to the outer spings of jack A, and pass from the inner contacts to the outer springs of jack B, and so through all the sections. If the number of this subscriber's line is between 1 and 200, the wires, after passing through all the sections, would return to section A, pass through the local jack, and end in the

* Paper read before the Institution of Electrical Engineers.

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indicator. A third wire in connection with the barrels of the jacks is also carried through all the sections, and is normally an insulated wire. This is the test wire by means of which an operator ascertains whether or not the line wanted is engaged at any other section. When an operator replies to a subscriber she inserts a plug into the jack of his line. The tip and ring of the plug connect to the line wires, and the sleeve joins the barrel of the jack to a battery, the other side of which is connected to earth or a common return. To complete the connection the jack of the line wanted is similarly treated. Should either of these subscribers now be asked for at another section of the board, the operator there would touch the barrel of that subscriber's jack with the tip of the plug with which she proposed to make the connection, when a current would pass from the test wire through her telephone, causing a click, and so advising her that the line was engaged. The spring jacks are made up in strips of 20, mounted on two parallel pieces of vulcanite 1⅜in. apart. I submit a sample strip of these jacks. The front piece is 11½in. by ½in. by ½in., and the distance from centre

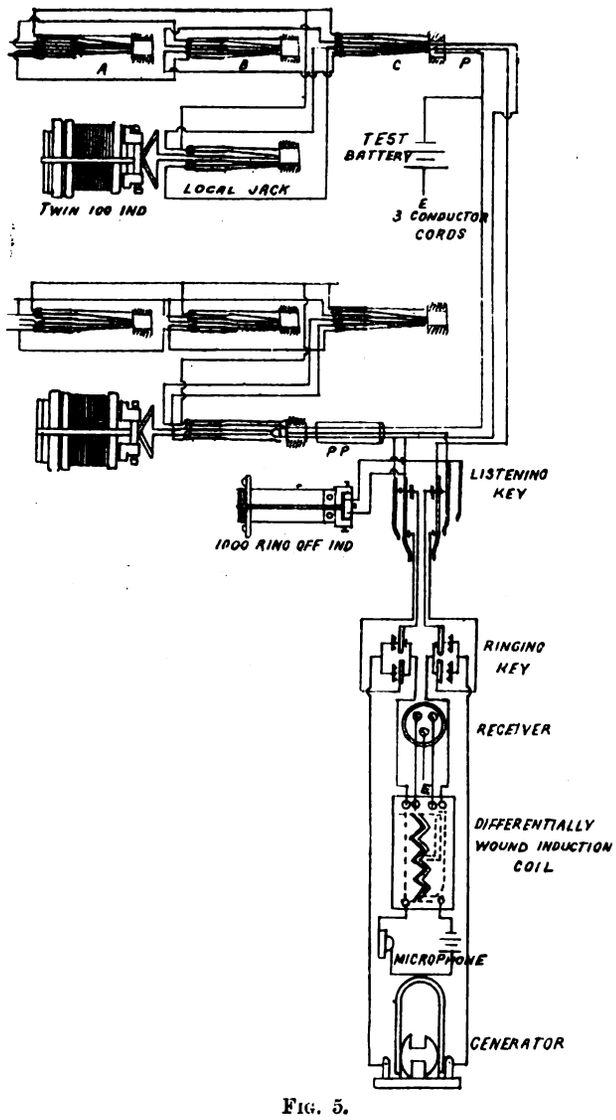

FIG. 5.

to centre of the jacks is ½in. The back part is slotted, and the springs which fit into these slots are shouldered, so that they cannot be forced out of position by the plug. Each jack has two long springs to which the line wires are connected, and these grip the plug. These springs rest on shorter springs (both being provided with platinum contacts), which are connected to the corresponding jacks in the succeeding sections of the board, and, lastly, to the local jack and indicator. A strip of metal is connected to the barrel of the jack and is carried to the back as a soldering tag, and to this the test wire is attached. These strips are secured to stiles in the upper portion of the board by special fasteners, which allow of any strip being readily withdrawn for repairing purposes. I have here a sample showing how one row of jacks is connected by cable with the corresponding row in the succeeding section of the multiple. The wires are carried throughout the switchboard in 63-wire cables, each cable serving 20 subscribers or one strip of jacks, and having three spare wires to provide for breakages. The copper conductor is No. 22 gauge, insulated with rubber and paraffined cotton. The wires are laid up in threes—two line wires and one test wire for each subscriber. Seven such strands are twisted together, and three such groups of wires are laid side by side and covered with cotton braiding saturated with paraffin. The size of the finished cable is about ⅞in. by ⅜in. The listening and ringing keys and their connections are the same as those shown with reference to small boards. The operator's telephone has received considerable attention of late years. It was, until lately, the practice to suspend the transmitter from the top of the board, and the receiver had to be held to the ear by hand. Now the transmitter is fitted in an aluminium case, which is fixed to a light breastplate of the same metal, and this is suspended round the neck of the operator, so that the mouthpiece is always conveniently placed for talking into. The receiver is also made up in a light form, and kept against the operator's ear by metallic springs or an elastic band. By the use of these instruments both her hands are left free for operating. The induction coil of the transmitter and the coils of the receiver are differentially wound, and the centre point of the latter coils is joined to earth to allow of the "engaged" test being obtained, and of the operator working earth-circuit and metallic-circuit lines on the same board indiscriminately. The earth being connected to the centre of

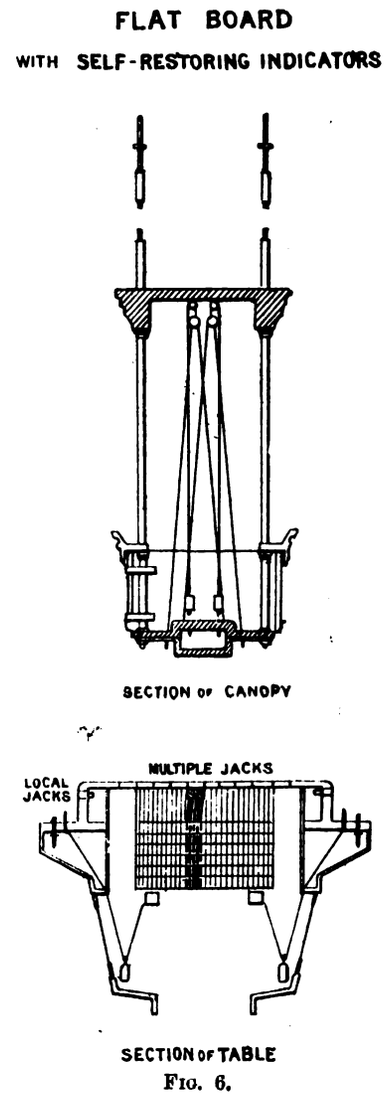

FIG. 6.

the differentially-wound coil has no detrimental effect on a metallic-circuit line. The boards just described are complete metallic-circuit boards, and are used very extensively in this country. They work satisfactorily on earth circuits, and, if necessary, may be employed on earth-circuit systems as transition boards. When on this system metallic circuits are joined to other metallic circuits they form a perfect metallic loop, but when joined to earth circuits one side of the metallic circuit is earthed at the exchange; the circuit so formed being but little better than a line with earth return throughout, the second line simply acting as a screen to lessen induction. All these connections are made in an exactly similar manner, the operator not having to distinguish between single and metallic circuits.

The problems in switchboard work have always been, firstly, How quickly can a connection be made? and, secondly, How can efficiency be best obtained? With reference to the first, the desired end is attained by reducing to a minimum the number of movements necessary, and making those movements as easy as possible. With reference to the second condition, in the earlier boards it was usual to leave the two line indicators in circuit when the lines were joined together;

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and the first step taken to improve this was to cut one out, or to cut out both line indicators, substituting a special indicator for the purpose of receiving the subscriber's clearing signal. The electromagnet of this indicator was, however, directly in the circuit. It was observed that any such electromagnet in the line circuit cut down the talking very considerably, one indicator having probably as much effect in reducing the efficiency of the speaking as 50 miles of an ordinary aerial line. The next step was to increase the resistance and

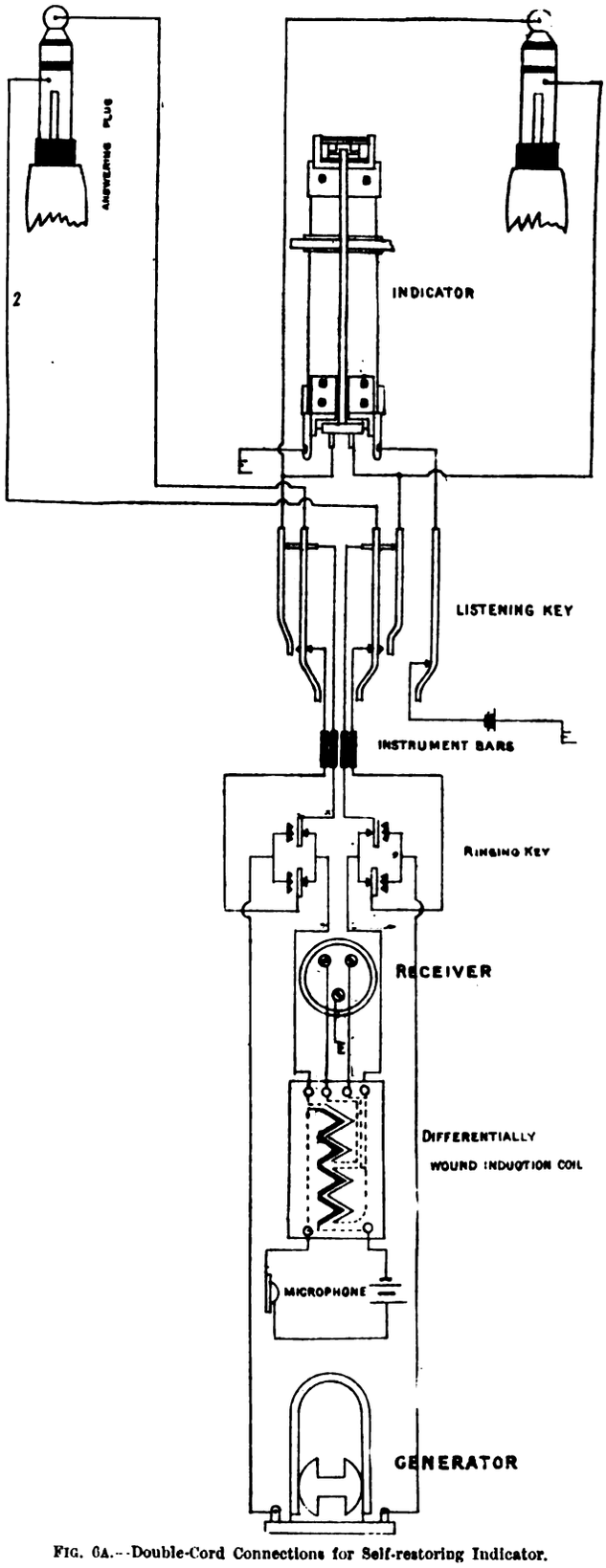

FIG. 6A.—Double-Cord Connections for Self-restoring Indicator.

self-induction of the ring-off indicator, and place it in shunt across the two lines of a metallic circuit, or as a tap to earth on single lines. It had also been found that trouble was sometimes caused by dirty contacts in the spring jacks. To obviate this difficulty some of the later boards have all the spring jacks wired in parallel, and the two line indicators, which are of special pattern, left in shunt. This system is sometimes called the "self-restoring" and sometimes the "branching" system; but, as the latter name had been correctly applied to other systems which had preceded it, and of which this is an extension, I prefer to use the former term. In this system (shown in diagram, Fig. 6 A and B) the work of the operator is lessened, inasmuch as the shutter of the indicator is automatically restored in answering the subscriber. This allows the indicators to be placed at the top of the boards, where space is not so valuable, and the spring jacks to be placed lower, thus bringing a much larger number within easy reach of the operator, and materially increasing the ultimate capacity of the Board. The general arrangement of this class of board is much the same as that previously described, except that, as just mentioned, the indicators are placed over instead of under the spring jacks. The apparatus, however, is somewhat different. The springs of the jacks are let into a solid slab of vulcanite. There are three of these springs, two being of equal length, and one shorter. The front of the slab of vulcanite carries two bushes, one behind, but insulated from, the other. The line wires are continuous throughout the exchange, ending at the subscriber's indicator. Branches are brought from these at each section, one to the short spring and the other to the inner bush of the jack. The two springs of equal length are joined, one to a common battery wire running round the exchange, and the other to the corresponding springs of all the jacks in the same line, and, finally, also to the indicator. This latter spring is also in metallic contact with the front bush of its own jack. When a plug is inserted in a jack, the tip comes into contact with one line through the short spring; the sleeve, through the barrel, with the other line; and the two springs of equal length are connected by an insulated metallic ring between the tip and the sleeve. The tip and the sleeve are joined to the two conductors in the flexible cord used for connecting two subscribers. It will be seen that when a plug is inserted into a jack the springs of the jack do not break any connection, and when the plug is withdrawn there is no contact point to be restored. The indicator (Fig. 3 A) consists of two separate single-coil electromagnets, both sheathed with iron, and fixed one in front of the other. To the back one, which has a resistance of 1,000 ohms, the line wires are attached. The front one, which has a resistance of 45 ohms, is connected on one side to the test circuit, and on the other to earth or to the common return of the restoring battery. When a subscriber calls, a heavy armature pivoted in front of the restoring coil is released, and falling forward a short distance lifts a light aluminium shutter, disclosing the subscriber's number. When the operator inserts the plug to answer the subscriber the heavy armature is drawn backward and held fast in its normal position so long as the plug remains in the jack. The aluminium shutter, of course, resumes its normal position at the same time.

As before explained, the front bush of each jack is connected to this restoring circuit, and the connections of the operator's instrument are so arranged that when she touches this bush with the tip of one of her plugs part of the current is shunted through her receiver, showing her that the line is engaged. As one of the connections is dependent upon the contact between the inside of the bush and the sleeve of the plug, which must fit somewhat loosely, the plug is provided with what we call "umbrella" springs. The ring-off indicators are of the same pattern as those above described, but are so arranged in connection with the listening keys that when the operator's instrument is in circuit the indicator is locked, but is free to respond to the subscriber's ring-off current when, by pushing the lever forward, this instrument is out of circuit. This class of board with self-restoring indicators is being introduced into London at the same time as the subscribers' lines are being metallic-circuited, and this work will be entirely finished in a few months. One of the principal exchanges fitted with this class of board is that at Lime-street, City. It is to be noted that as these self-restoring indicators require permanent current to keep them locked while the lines are in use, special arrangements have to be made at each exchange for providing this current. As a typical case, I may mention that at Lime-street the current is supplied by 12 E.P.S. cells of 23 L type, charged by an Elwell-Parker dynamo running at 800 revolutions and giving an output of 45 amperes at 15 volts. This dynamo is driven by a Tangye gas-engine of 1 h.p. nominal. The engine also drives the generators which supply the ringing current. One-half of the cells—*i.e.*, six—are in use at one time, arranged in three groups of two each, and each group supplies current for one-third of the whole exchange—*i.e.*, about 1,300 indicators. The current for the operator's transmitters is supplied by a similar number of cells divided in the same way. In this case each group supplies current for about 30 transmitters. To prevent overhearing it is found essential that the circuit of each transmitter should be taken separately by direct leads from the terminals of the batteries. A duplicate set of cells is provided, and one set is being charged whilst the other is in use.

From what has previously been said as to the number of jacks required for an exchange with 5,000 subscribers' lines, and the increased proportion in the number required when the exchange is fitted for 8,400 lines, it is evident that, apart from

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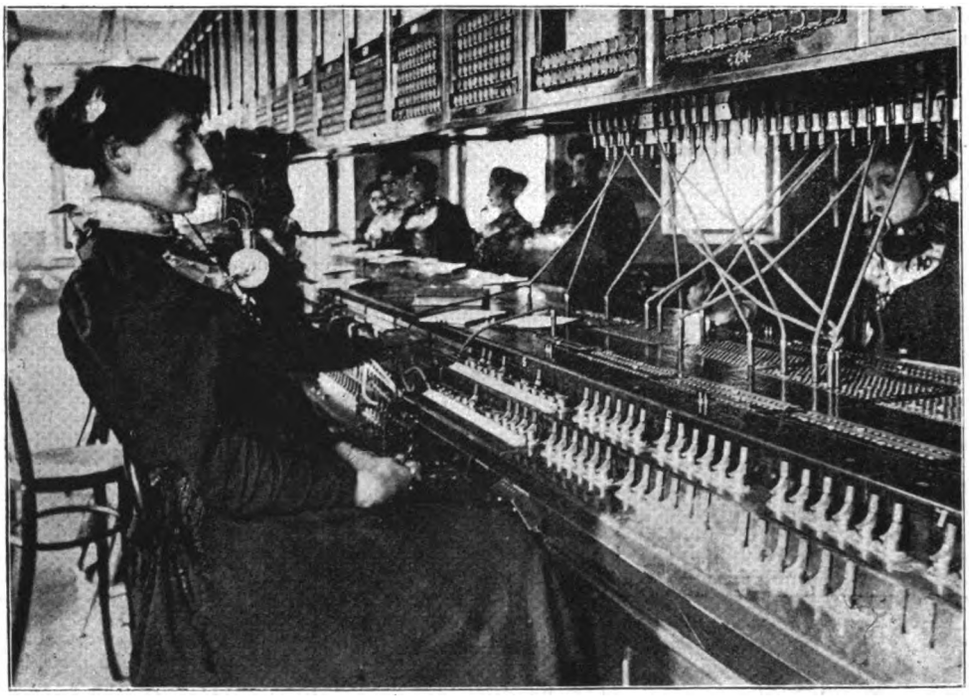
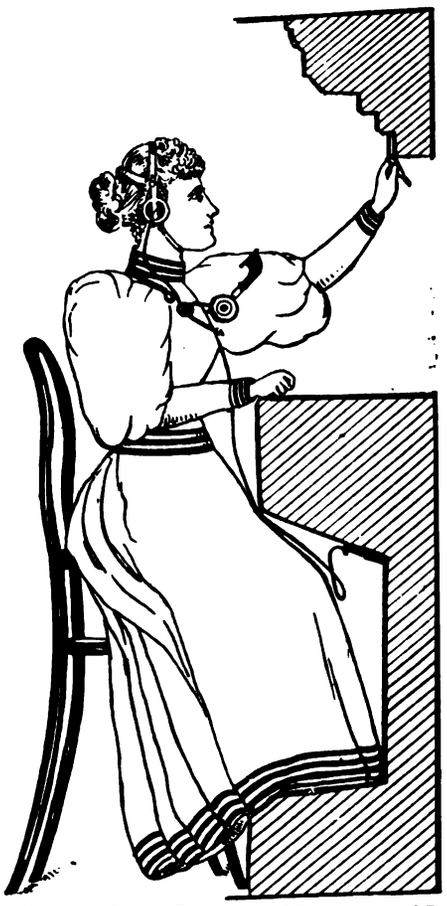
cost, the question is a very serious one; indeed, it becomes so serious that while on every hand it is acknowledged—and I think rightly acknowledged—that the multiple system is the best, a point may be reached where the vast number of jacks and large quantity of cables used introduce troubles almost equal to those previously overcome by the use of the multiple board. In America they are trying to meet the difficulty to some extent by the introduction of what is known as the "divided multiple" board, whilst I have endeavoured to meet it by the use of flat boards. The weak feature of the divided board is that no connection is made without being dealt with by two operators, and, consequently, the chief advantage of the multiple system—viz., that the operator who receives a call completes the connection—is lost. But with the flat board, fitted as I shall presently describe, this advantage is retained, whilst, broadly speaking, one-half only of the line jacks and cable are needed. It is about eight years since I commenced the use of flat boards, when a small one was fitted at Paisley. The working of this board proved that the flat board as a system, if fitted with the proper material, could be worked very successfully. I am aware that flat boards had been tried in this country before that date, and that some were in use in America; but, so far as I can learn, the number of jacks used was not less than that on the ordinary upright board. I therefore cannot see the reason for introducing them, unless, indeed, it was considered they were better flat than upright from an operating point of view. I am aware that there are in this and in other countries telephone engineers of the highest reputation who are not at one with me on the question of the advisability of introducing flat boards; but, after the fullest and most mature consideration and experience of their working for several years, I see no reason why they should not be used largely under certain conditions. When flat boards are fitted up in comparatively small exchanges, the saving on the jacks and cable is not equivalent to the extra expense of the framework, and therefore I do not recommend their use for small exchanges. But for large exchanges with from 2,000 to 8,000 subscribers' lines there is in my mind no doubt that this is the best class of board to use. The principal reasons for this opinion are: (1) That in consequence of the smaller number of jacks and quantity of cable used, better speaking results are obtained, and fewer faults occur. I have only to point out to you, as electrical engineers, that for an 8,000-line exchange the number of soldered connections is reduced in the flat, as compared with the ordinary upright board, by over half a million, to bring this point of efficiency forcibly before you. (2) In many cities it is very difficult to find switch-rooms large enough to take from 5,000 to 8,000 subscribers' lines; but with the flat-board system this difficulty does not exist to the same extent, as practically they take only half the floor space required for upright boards. There are likewise the questions of the cost of the boards, rent of switch-rooms, lighting, heating, etc., which bear some proportion to the space occupied; but these are secondary considerations, the principal one being efficiency.

I should like to make it perfectly clear that, while I consider flat boards the right pattern to use under certain conditions, I do not recommend their use in all circumstances. With self-restoring indicators, which do not require to be within reach of the operator, and may consequently be placed overhead, and the jacks for use with which have no breaking contacts, with the consequent trouble arising from dust, I consider them the right class of board to use. I also consider the flat board the best to use in connection with exchanges of all sizes worked on the call-wire system. Fig. 6 shows a section of the type of flat board with self-restoring indicator before referred to. The table carries the multiple spring jacks, the barrels all facing upwards. The local, or home-section, jacks, which are always used when answering subscribers, are at the side on the upright. The listening and ringing keys are fixed on a shelf at the side of the table, one half of the cords and plugs being fitted on the same shelf, and the other half in a canopy above the table, which canopy also carries the self-restoring indicators. The lower plugs are the answering plugs, and are inserted in the local jacks only; the overhead plugs are used only for making connection with the line jacks on the top of the table. The operators, each working 50 subscribers, sit on both sides of the flat table; and the 6ft. 6in. section of multiple jacks, which, on the upright board, is common to four operators with 200 subscribers, is here common to eight operators working 400



View of the Telephone Switch-Room in High Holborn.

subscribers. The framework is built of T and L iron, faced with wood, the details being as shown by sectional drawing at Fig. 6. Vertical oblong iron frames cross the tables at regular intervals of 11½in. for carrying the jacks and cables. The ends of the strips of spring jacks rest on and are fastened



View of Operator, showing Breast-plate, Microphone, and Receiver.

to the upper edge of these frames, the jacks being placed in a vertical instead of a horizontal position. The cables are carried by racks inside these frames. Each block of 100 jacks occupies a space of 11½in. by 2½in., and as there are six such blocks in the length and 10 in the width of the multiple it will be at once

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seen that the board has a capacity of 6,000 lines. A special type of 63-wire cable is used. The cable is formed of seven groups of three strands of three wires each, laid side by side, and covered with braided cotton, the external dimensions of the cable being 1·312in. by 0·260in. The canopy is hung from the ceiling by rods at 3ft. 3in. centres, and, as before mentioned, carries the indicators and half of the connecting plugs and cords. The strips of indicators are fixed in the sides of this canopy, being hinged to allow of their opening outwards for convenience of inspection and repairing. In connection with flat boards I mentioned the call wire, and this introduces us to a system of working telephone exchanges differing largely from any I have previously described. The use of this system has been very much discussed by telephone experts. In the call-wire system each subscriber has, in addition to his direct line to the exchange, the use, in common with a number of other subscribers, of a wire known as the "call wire," which, starting from the exchange, is branched into the offices of, say, 50 subscribers. On this call wire the operator attending the subscribers is continuously listening in the exchange. The subscriber's instrument is fitted with a switch which enables him to place it in connection with the call wire, on which he asks for the subscribers he requires. These, of course, are connected on his direct wire, and are rung up by him, the operator not interfering with the connections until told on the call wire to clear. It will be seen from this that when a subscriber takes a long time to answer his bell (and there are many of them who do so, especially in London) he has to explain to the calling subscriber the reason of the delay, which would in all probability have been otherwise attributed to the operator. There being 50 subscribers connected to the telephone of each listening operator, it is evident that any number of them may try to speak at the same time; but here, as in all matters of business, common sense, as a rule, prevails, and a subscriber coming on to the call wire and hearing others talking to the operator does as he would do if booking a ticket at a railway office—*i.e.*, takes his proper turn, and so the calling is done without confusion and more quickly than with the indicator system. It must be clear to everyone who considers the matter that an operator cannot attend to two subscribers at the same time; and, generally, it is quite as satisfactory to a subscriber to listen until he hears that the operator is free as to ring time after time until the operator is able to attend to his call. It must be obvious, however, that the number of subscribers a call wire will accommodate is limited, and, as hereafter explained, great confusion would arise from overloading it.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 26.

The PRESIDENT (Dr. John Hopkinson) in the chair.

A list of the candidates balloted for and elected appeared in our last week's issue.

The first business of the meeting was to receive the balance-sheet of the past year. As this had been printed and circulated among the members it was taken as read. (A copy of it was published in our columns last week.)

The **President** formally moved the adoption of the accounts.

Major-General Webber seconded this.

Mr. Raworth then said he had some remarks to make on the subject of the balance-sheet, but suggested that if it would suit the convenience of the meeting the discussion of the subject might be adjourned.

The **President** said that could hardly be done after the matter had been announced for that night. He, however, called Mr. Raworth's attention to the fact that an important paper was to follow.

Mr. Raworth said that it then became his duty to deal with the matter that evening. He had taken the trouble to look over the balance-sheet very carefully and to thoroughly understand it. At the outset he had come upon some peculiarities which had determined him to get to the very bottom of it, so that he might be able to assist other members to understand it. His remarks on the subject would be commendatory, explanatory, and critical. He found that their secretary had kept the accounts in a thoroughly good manner, and after he had taken the figures to pieces and constructed with them a proper balance-sheet as it should be constructed, he found the amount came out absolutely correct. It would be observed that this was the first time in the history of the Institution that they had been treated to a balance-sheet. On previous occasions it had always been called an estimate of assets and liabilities. Now, however, it was a balance-sheet, and there was a very great deal of difference between those two things Members might perhaps look upon him as an engineer, and not a skilled accountant, and therefore he had referred the figures to Mr. Hodgson and Mr. Garcke, who confirmed his corrections, and after that to a gentleman of the very first standing in such matters in the city of London. The latter said the balance-sheet was not very much worse than the balance sheets of such institutions generally were. They were always very lax. That was much to be regretted, because in such cases, more than in the case of a mercantile company, it was nobody's business to interfere, and the accounts were liable to get into a bad condition. Mr. Raworth then proceeded to criticise the figures of the balance-sheet in detail. One item they would find was for furniture—"as per last balance-sheet"—£214, less depreciation £14—£200. Now, this was their first balance sheet, and so far as he could see the £14 depreciation was nowhere accounted for. Then looking at the item "books, pictures, etc.," the sum total of that had risen from £1,043 to £1,093 in the year. Thus there appeared an appreciation of £50 without any expenditure to justify it so far as he could see except £8. 2s. for books and periodicals. He thought it would be seen from this specimen that the balance-sheet contained some very strange peculiarities. Now he looked upon an absolutely sound balance-sheet as the greatest security that the Institution could have for the safe transmission of its funds to future generations. The present members would pass away, and the best legacy they could leave their successors was a perfectly sound balance-sheet. Now was the proper time to secure it, for if they put it off, maybe until they had some defalcations, putting it right would be a very painful operation. He did not want, however, to press his amendment to a division that night, and if the President thought he had proved his case sufficiently he would stop there (No sign of assent was made by the President). Next, then he, would take a fund of which they were all proud—the Salomons scholarship fund Now, when he (Mr. Raworth) was making out a proper balance-sheet he could not at first make it balance by £570 13s. 6d. He had that more in assets than there ought to be, and had to find where it came from. Now, if money could get into a balance-sheet without being accounted for, it was equally possible for it to get out without being accounted for. He found at last that the Institution was indebted to Sir David Salomons for the sum in question, but they had not made any acknowledgment of the gift. He had learnt one thing during the last fortnight. He had learned that no one gave more attention to the affairs and honour of that Institution than Sir David Salomons. He had not only given them most liberally in money—they all knew he was a man of great wealth—but he had given them his time and attention as well. On a former occasion there had been a note made that a specific sum was the gift of Sir David Salomons, but with the sum at present in question when they looked at the balance sheet they would find no mention of the source of the gift. He did not know whether the Council would wish him to bring any further evidence——

The **President**: I must leave it entirely to you, Mr. Raworth, but I call your attention to the clock

Mr. Raworth: There is no limit.

The **President**: I know it. We will be patient.

Mr. Raworth, continuing, said he would next turn to another gentleman who must be nameless, for he had not been able to discover who it was, but that gentleman it appeared had given a sum of four guineas to the library fund, and they had done nothing with it. So far as the accounts showed, they had taken that sum and applied it to some other purpose. There was another matter he would bring before their notice. Their building fund had stood at £3,000, and they had transferred to it £500. It had also produced interest £90, but it only stood at £3,500 on the accounts instead of £3,590, so that it appeared that the poor fund had been swindled out of £90 somewhere. It was a very nice thing to possess £3,000 worth of capital, but if you did not get any interest on it you were not much the better off for it. If he were to present them with an oyster bed worth £10,000, but on the condition they were to have no oysters from it——

The **President**: I think, Mr. Raworth, that you might get along a little more rapidly without all this illustration.

Mr. Raworth: I will give you no more illustrations.

The **President**: Well, you have already occupied a quarter of an hour.

Mr. Raworth, continuing remarked that the Institution had a surplus of £1,173 16s. 6d. The Institution was founded for the purpose of promoting the advance of electrical science, yet they had only expended £23 on premiums while the Institution of Civil Engineers had spent £493. 9s 6d. It had been remarked that very good papers that might be read there had been taken to the Civil Engineers Possibly this was the cause. They had an enormous number of young members, and many would be willing to read papers if they could afford it. The drawings on the wall, for instance (Mr. Dane Sinclair's), must have cost something like £20 to make.

The **President**: I think Mr. Raworth, you are diverging upon matters which have not anything to do with the question to be discussed.

Mr. Raworth thought that how the money was expended had certainly to do with the balance-sheet. He had not wished to move this resolution if the Council would have met him on the point, but as it was, without referring to other items, he would move that the balance-sheet be referred back to the Council for amendment.

Mr. Mordey seconded the amendment.

The **President** remarked that he would simply ask the accountant to give any explanations that might be necessary as to the points raised.

Mr. Biggs (of Messrs. Wagstaff, Blundell, Biggs, and Co., the accountants to the Institution) said that the balance-sheet showed the assets and liabilities, as he understood them, in the usual form. Gentlemen who were unacquainted with accounts might have some difficulty in understanding an ordinary balance-sheet. On the right-hand side they would find the investments of the Institution. As to "furniture as per last balance-sheet," he was afraid that those words were a slip, because there was no last balance-sheet; but as to the £14 depreciation, Mr. Webb had fixed on the sum in consultation with the auditors as quite sufficient, and that

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at the amount the furniture was taken at there would probably be no need for any further depreciation, since it would represent the value of everything 10 years hence. Great care had been taken in estimating the value of the overdue subscriptions. As to the item for books and pictures other than the Ronalds library, these had mainly been acquired by gift As to valuing them, he supposed that any six gentlemen would arrive at six different conclusions. It was quite sufficient for the purpose of the account to value them at £1,093 On the other side of the account, the different funds were set forth. The premium and other general funds must be shown separately under the provisions of their articles of association. The Salomons scholarship fund was also shown separately, as it was applicable to a specific purpose. The building and general fund comprised £6,700 odd. That the distinction was made between them was by the decision of the Council. The balance sheet boiled down to nothing showed the assets of the Institution to amount to £12 000 odd. He did not know that he could give any other explanation, and it seemed to him that the balance-sheet gave all the information necessary. Mr. Raworth had spoken of a sound balance-sheet, but he (the speaker) thought that when a balance-sheet showed £10,000 of assets that could be realised to-morrow against no liabilities to creditors they could not get into a much sounder condition. He did not know the name of the donor of the four guineas to the library fund, nor was it part of his duty to know it. With regard to there being no memorandum in the balance sheet that a certain sum was Sir David Salomons's gift, it seemed to him that the balance-sheet was not the place for remarks of that character, nor was it the place for them to express their gratitude. The donation was no doubt acknowledged on the minutes at the time it was made and the gratitude of the Institution suitably expressed.

The **President**: I will not waste any time after the amount of time we have unfortunately lost, but will at once put the amendment to the meeting.

Mr. Raworth: Nothing has been said in reply to my statements.

On a show of hands, 27 were held up for the amendment and 17 for the resolution, the greater part of the meeting voting neither one way nor the other.

The amendment was accordingly declared carried, and the reading of Mr. Dane Sinclair's paper on "Telephone Exchanges" was proceeded with. At its conclusion no time remained for its discussion, and after the usual vote of thanks the discussion was postponed to April 16,

THE PHYSICAL SOCIETY.

At the ordinary meeting on March 27, Prof. Carey Foster, vice-president, in the chair,

Prof. J. A. Fleming read a paper on "**The Edison Effect**" The Edison effect alluded to in the title of the paper is that if a metal plate is placed inside the loop of an incandescent lamp, then a galvanometer, of which one terminal is connected to this metal plate and the other to the positive lead of the lamp, will indicate a current passing from the lead to the plate. If, however, the galvanometer is connected to the plate and the negative lead, no current passes. Prof. Fleming, by connecting the poles of a condenser, firstly, to the two leads, secondly, to the plate and positive lead, and, thirdly, to the plate and negative lead, and in each case discharging the condenser through a galvanometer, has shown that after the lapse of a certain time, depending on the position of the plate, if the lamp is working at about four watts per candle, the potential of the plate falls to that of the negative lead. If the plate, instead of being inside the loop of the filament, is outside, then the time taken by the plate to acquire the potential of the negative lead is considerably longer. The space between the plate and the negative lead exhibits a kind of unilateral conductivity, for a battery having a low voltage is able to send a current from the plate to the negative lead, but not in the opposite direction. If, instead of using a cold metal plate, a second filament maintained in a state of incandescence by an insulated battery is used, then a current can be obtained between this filament and both the positive and negative leads. If the voltage on the lamp is raised considerably above that required to give 1 c.p. for four watts, then a current can be passed from the plate to the negative lead, while a galvanometer connected to the positive lead and the plate will indicate the passage of a current from the positive lead to the plate When the lamp is in this condition the space between the plate and the negative lead is very sensitive to the effects of a transverse magnetic field, such a magnetic field causing a large increase in the resistance. The curve showing the connection between the current passing from the positive lead to the plate and the volts between the terminals of the lamp is found to be discontinuous. As the volts are raised the current suddenly increases about tenfold, and it is while the lamp is in the condition corresponding to this upper portion of the curve that it is sensitive to the influence of the transverse magnetic field. By using a movable plate it has been found that the minimum current is obtained when the plate is nearer the positive than the negative lead. When an alternating current is used to supply the lamp, a continuous current can be obtained passing from the plate to either of the leads. If a small platinum cylinder is placed surrounding each of the leads, then a current can be obtained between each of the cylinders and the positive lead, but no current between the two cylinders. The largest effect occurs when a cylinder near the end of the negative lead is connected to the positive lead. The author considers that his experiments show that the resistance of a vacuum tube to the passage of a discharge would be greatly reduced if the cathode were made incandescent.

Prof. S. P Thompson said he would like to have some information as to the state of exhaustion of the lamps—whether this was such as is found in ordinary commercial lamps, or whether it more nearly approached that used by Crookes. A great change in the conductivity, etc., took place at an exhaustion slightly greater than that ordinarily found in incandescent lamps. It would be of interest to vary the size of the cathode, and to investigate whether the magnitude of the effects observed depended on the fall of potential per unit length along the filament. Another point was whether the position of the plate for which the effect was a minimum was the same for all lamps, or whether it changed with the volts and the length of the filament employed. Again, did the minimum occur at a certain fraction of the distance between the positive and negative leads, or, as was the case in some of the phenomena observed by Crookes, at a definite distance from either of the leads. These points might be investigated by means of a lamp with a straight filament where the fall of potential per unit length along the filament might be the same as with the loop-shaped filament, but the fall of potential per unit length in the vacuum would be different. The author's proposed experiment of heating the cathode by concentrating on it the rays of a lamp did not seem to him (Prof. Thompson) to differ materially from Crookes's experiment, in which an incandescent wire heated by a current was used as the cathode.

Mr. Skinner said that the heating of the cathode by means of a "burning-glass" could easily be carried out.

Mr. Blakesley pointed out that it would be quite possible to produce an increase of the current by means of a magnet.

Mr. Serle said that Prof. J. J. Thomson had shown that a magnet affected the conductivity of a gas.

Prof. Fleming, in his reply, said that no doubt the effects were largely dependent on the vacuum in the lamps. The lamps employed were exhausted to the ordinary commercial vacuum. Since it was found that the "treating" was more worn off the negative leg of the filament, and that a screen placed between the legs of the filament was more blackened on the side turned towards the negative leg, it would appear that the particles of carbon were shot off from the negative leg, and hence, perhaps, the charge was carried by these carbon molecules.

A paper of a purely mathematical character, entitled "**Notes on the Electromagnetic Effect of Moving Charges**," by **Mr. W. E. Morton**, was read by **Mr. Serle**, who also made some remarks on his own investigations dealing with this subject.

The society then adjourned till April 24.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Tuesday at Winchester House, E.C., Sir Massey Shaw presiding.

The **Chairman**, in moving the adoption of the report and accounts, a copy of which appeared in our last week's issue, first referred with regret to the illness of Sir John Pender, the chairman of the Company. Sir John Pender had guided the operations of the Company from its commencement, and he did not hesitate to say that the present position of the Company had been in the main due to the commercial ability and indefatigable energy displayed by Sir John Pender in its interests. Dealing then with the report and accounts, the chairman said their expenditure had practically been confined to five items—namely, buildings, £5,467; machinery, £5,016; mains £18,026; transformers and connections, £12,884; and meters, etc., £3,038. The expenditure on buildings was due to the Sardinia-street extension, where a large increase of generating plant had been required. The expenditure on mains was £4,000 more than in 1894. This had been necessary to meet the statutory demands on them. In consequence £31,640 more debenture stock had been issued, and shareholders would be glad to learn this had been done at a premium of 16 per cent., which had been placed to the capital account. The occasion of the fire at Sardinia-street buildings had been taken advantage of for a thorough overhaul of the boilers and furnaces, and the cost had been paid out of revenue. The maintenance of mains had amounted to very little on account of the loop wire system adopted by the Company. The parliamentary charges were due to the struggle that was constantly going on with competitors who wanted to take advantage of the work the Company had done and make inroads on their district. It was satisfactory to know that they were paying a 4 per cent. dividend and that the accounts were such that a very little more would place them on a sound 5 per cent. basis. As to the assistance received from the London and City companies at the time of the Sardinia-street fire, the Chairman remarked that though their trunk mains worked admirably it was necessary, in view of the largely-increasing demands upon them, to purchase an amount of current from the other companies. They were now, however, able to meet all their requirements, but the connections made would remain to the mutual advantage of all concerned. He might add that though the fire broke out between 6.30 and 7 in the evening, all the theatres supplied from the Company's mains, except one, were duly lighted that evening. He regretted that the Charing Cross Company had been successful in their application authorising

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them to compete with the Company in the Strand. They had had that competition from the first in the St. Martin's district, and it might be taken for granted that anything that might be necessary to protect their interests would be done. Their engineer (Mr. Frank Bailey) had laid before the Board estimates of all work likely to be required up to 1900. They would shortly be wanting transformer sub-stations in some of their districts besides other work. A new issue of capital would be required, but in what form the Board had not yet decided. The shareholders would of course, have to be consulted on this point.

Admiral Lord John Hay seconded the resolution

Mr. Harrison Cripps as a shareholder to the amount of £20,000, said he was not altogether satisfied with a dividend of 4 per cent. To produce £100,000 worth of electricity it had cost the Company £68,000 more or less They might put it at 68 per cent. Now, it cost the Westminster Company 43 per cent, the St. James's 51 per cent., and the City of London 53 per cent.—*i.e.*, it cost them 18 per cent. more for production than these companies, which would amount to a 3 per cent. extra dividend. A large item in the cost of generation was the coal bill. For every £1 worth of current it seemed to cost the St. James's, Westminster, and City of London Companies from 2s. to 2s. 1d. for coal, while it cost them 5s 4d. Could the chairman explain this?

Mr. Geipel said Mr. Cripps had referred to the excessive expenditure on coal. It was the loop system which the chairman had spoken of that was in part the cause of it. They were using small transformers on the consumers' premises, and their transformer loss was consequently enormously greater than it would be if they were banked together upon the modern system.

The **Chairman,** in reply, said the coal consumption had been unduly large owing to the fire at Sardinia street, which compelled them to give their attention to keeping the supply going rather than effecting an economy of working. With reference to the mains, they had a class of mains which cost little but involved a greater coal consumption as compared with the other companies which had more expensive mains and a lower coal consumption. Besides, their district was a very large one, and they had a large number of mains that had not been taken advantage of by consumers to the extent that he hoped they would be eventually. The transformer sub-stations they intended constructing would meet the rest of Mr. Geipel's suggestions.

The resolution was then carried unanimously adopting the report, and authorising a dividend of 5s. per share, making with a previous dividend a rate of 4 per cent. per annum, and the retiring directors and auditors were re-elected.

TRAMWAYS ELECTRICAL TRACTION COMPANY, LIMITED.

A meeting of this Company was held on Monday last at 7, Poultry, E C., Lord Richard Browne presiding.

The **Chairman,** in moving the adoption of the report, a summary of which has already been given in these columns, said the report spoke for itself, but as allusion had been made in it to the proposed liquidation of the Company, a few words might be said as to the circumstances that had led to that being proposed. Many of them who were old shareholders in the Tramways Company of France would remember when the Rouen Company was not in a flourishing condition. The town of Rouen was very hilly, and the number of horses that had to be employed for extra traction was very large in proportion to the number required for tramways generally, and this caused great expense. The bulk of the shares of the Rouen Company were owned by the Tramways Company of France, which was an English company, on the Board of which he and some of his colleagues were directors. After due consideration, the Rouen Company determined to adopt the system of electric traction, and to carry out that purpose formed the Tramways Electrical Traction Company, whose articles of association, however, enabled it to do any other similar work The Tramways Company of France was wound up, and this Company purchased all the shares which that company owned in the Rouen Company. Those shares were the 15,000 ordinary shares of this Company. They then made a contract with the French Thomson-Houston Company for the due equipment of the line. Most of the Rouen lines were opened a few weeks ago, and the formal opening took place on March 22 with very great success. He believed this Company had conclusively proved the value of electric traction as compared with animal traction. The result of their success had been that certain offers had been made to them by French financiers to acquire all the shares held by this Company in the Rouen Company, and the negotiations had resulted in an agreement under which, while the capital of this Company remained absolutely intact—namely, 15,000 preference shares, £5 paid, and 15,000 ordinary shares of £1. 10s. each, fully paid—there was a balance which enabled them to pay interest of 6 per cent per annum on the preference shares and a dividend of £5 per share on the ordinary shares, leaving £2,089 to be carried forward. He considered that in returning the ordinary shareholders their capital, with the addition of a dividend of about 333 per cent., they had not done by any means badly. Of course, they might carry the Company on; but as they had realised practically their whole property, and had not at the present moment got any work in view, it would be better not to keep the shareholders' capital lying idle. If at any time the Board should see any prospect of undertaking a similar job, they had the shareholders' names and would be glad to invite them to participate in it.

Mr. J. B. Concanon seconded the resolution, expressing his regret that many of the old shareholders in the Tramways of France Company had not availed themselves of this opportunity of joining this Company. The Board had the very highest opinion of the merits of electric traction He might say that the Board had not by any means accepted the first offer, but had practically got their own price

The resolution was carried unanimously.

Mr. Austin moved a resolution authorising the payment of £2,000 to the directors as additional remuneration for special services They had a balance of £2,089 available for that and some interest accruing which would be sufficient to pay the costs of winding-up, so that it could be done without dipping into what the shareholders were to receive for their shares.

Mr. Beaton seconded this but asked if the repayment of £5 on the £1. 10s. could not be made as a repayment of capital so as to avoid the income tax on it It was really a case of the recovery of lost money so far as concerned many of the old shareholders in the Tramways of France Company.

Mr. Gilbert (of Messrs. Ashurst, Morris, and Crisp, the Company's solicitors), said it could not legally be done. It was also stated that the Board had considered the subject, and the **Secretary** said he had already received a communication from Somerset House.

The resolution was then carried unanimously and the meeting closed with the usual vote of thanks.

In acknowledging this, the **Chairman** stated that the greater part of the credit of the successful issue of the negotiations was owing to Mr. Concanon and Mr. Haldinstein.

There will be two more formal meetings to authorise the winding-up of the Company.

ANGLO-PORTUGUESE TELEPHONE COMPANY, LIMITED.

The ordinary general meeting of this Company was held last week at the Company's offices, 53, New Broad-street, Sir Alexander Armstrong presiding.

The **Chairman,** in moving the adoption of the report, stated that the Company continued to make good progress, the number of subscribers, both in Lisbon and Oporto, having increased during the year under review. They proposed to pay a dividend of 2½ per cent, and to place £3,000 to the reserve account, leaving £4,279 to be carried forward. The Board confidently hoped that in the future they would be able to augment this dividend The continuance of the high rate of exchange between the two countries had tended seriously to cripple the Company's financial resources. At the date of closing the accounts the number of paying subscribers in Lisbon was 1,212 and in Oporto 1,233, and the actual gross income in 1895 was over £16,000. Their relations with the Portuguese Government and the municipal authorities continued to be friendly.

Mr. C. L. W. FitzGera'd seconded the motion, and it was carried.

WILLANS AND ROBINSON, LIMITED.

Directors: Mark Robinson, M I.C.E. (chairman), Sir Gilbert A. Clayton-East, Bart., Captain H. Riall Sankey, R E. (retired), M.I C.E

Fourth half-yearly report of the directors and statement of accounts to be submitted at the ordinary general meeting of the Company to be held at the City Terminus Hotel, Cannon-street, E C., on Wednesday, April 8, 1896, at 3 p m.:

The Company's business continues to develop in a thoroughly satisfactory manner. Although, for reasons explained in previous reports, new business has been little sought for, the horse-power of Willans engines ordered in 1895 was 27 883, against 26,624 in 1894. These figures compare, it will be remembered, with 18,950 h.p. in 1893, the last and best year of the old company. Even more significant is the fact that in less than three months of 1896 the horse-power ordered has reached 22,200, a development which, if more or less exceptional, yet indicates the probability of a rapid growth of business in the future. The results of the half-year's work have been as satisfactory as in any previous period, notwithstanding that the operations of the Company have been hampered, even more than before, by inadequate and, therefore, uneconomical means of production. After writing off as depreciation from plant, patents, etc., the sum of £3,769. 13s. 4d, the balance to the credit of profit and loss account for the half-year (including £319. 10s 2d. brought forward from last half year) is £11,832. 14s. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 7 per cent. per annum (as before) upon the ordinary shares, together amounting to £7,224. 19s. 5d. The amount payable to the directors, in accordance with the articles of association, is £1 286. 9s. 4d., and it is proposed, as on the last occasion, to carry £2,500 to the reserve fund. The balance, £821. 5s. 3d., it is proposed to carry forward. By the proposed appropriation the reserve fund, as the result of the first two years' working, will reach £7,646 9s. 11d, and of this sum the year 1895 will have contributed £5,000. The new works at Rugby are not yet in a position to assist in the production of engines, partly through delay by the contractor for the structural steelwork, partly from the necessity which has already arisen for extending the new buildings, and for commencing others which it had been originally intended to defer, the directors having judged it advisable to prepare for manufacturing operations at Rugby on a larger scale than was contemplated at the date of the last report. A number of the lighter new machine tools, intended eventually for Rugby, have been installed in a temporary building near Thames Ditton, where they are doing excellent service. The necessary authorisation for the contemplated issue of debenture

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stock should now be given, and a resolution will be submitted to the meeting to that effect. In view of the remarkable expansion of the business, and of the necessity which may arise for even further extensions at Rugby, the directors think it will be prudent to take powers to borrow up to the limit allowed by the articles of association—viz, £112,500—but so far as they can foresee at present an actual issue of £75,000 may suffice. The exact conditions will be best left for settlement when the issue is made but there is every reason to believe that the Company will be able to place the stock upon favourable terms. The mortgages upon the Thames Ditton freeholds have been paid off The auditors, Messrs Cooper Bros. and Co., retire, but are eligible for re election.

Dr. BALANCE SHEET, DECEMBER 27, 1895.

	£	s	d.
Capital issued*—			
22,500 6 per cent. preference shares of £5 each...	112,500	0	0
22,500 ordinary shares of £5 each	112,500	0	0
	£225,000	0	0
Workmen's bonds	1,130	0	0
Sundry creditors	11,138	18	8
Reserve fund	5,146	9	11
Profit and loss account—brought forward from last account, £319 10s. 2d.; profit for the half-year ended December 27, 1895, £11,513. 3s 10d.	11,832	14	0
	£254,248	2	7

* The authorised capital is £300,000.

Cr.	£	s.	d.	£	s.	d.
Freehold property, Ferry Works, Thames Ditton—as per last balance-sheet, June 28, 1895	22,242	1	5			
Less depreciation written off ...	402	0	10			
				21,840	0	7
Freehold property at Rugby—as per last balance-sheet, June 28, 1895..	4,577	13	3			
Additions during the half-year	5,222	17	10			
				9,800	11	1
Leasehold property at Avern Mills				286	3	2
Plant and machinery—as per last balance-sheet	45,152	10	5			
Additions during the half-year	2,188	12	2			
	47,341	2	7			
Less depreciation written off ...	2,435	12	7			
				44,905	10	0
Patents—as per last balance sheet	9,630	18	0			
Additions during the half-year	326	2	4			
	9,957	0	4			
Less depreciation written off ..	931	19	11			
				9,025	0	5
Purchase of goodwill of business				37,879	14	11
Work in progress on December 27, 1895.....	26,226	10	4			
Deduct payments by customers	1,578	19	10			
				24,647	10	6
Materials and stores and own manufactured stock articles.....				24,432	7	10
Engines in stock				2,398	8	0
Debtors				46,179	10	2
Investments on account of reserve fund, at cost ...				5,146	9	11
Other investments, at cost				9,893	8	6
Cash—at bankers, £17,744. 3s.; in hand, £17. 10s. 6d.....				17,761	13	6
Proportion of local rates paid in advance				51	14	0
				£254,248	2	7

PROFIT AND LOSS ACCOUNT, HALF-YEAR ENDED DEC. 27, 1895.

Cr.	£	s.	d
Rent, rates, and taxes	297	8	1
Mortgage interest..	185	1	6
Salaries, including directors' remuneration	4,230	4	11
Contingent salaries to employés	462	12	11
Fire insurance	132	18	1
Legal and professional charges	119	5	4
Advertising.....	470	19	10
Books, stationery, and printing	327	9	4
Postages and telegrams	195	14	10
Travelling, hotel, and general charges	270	3	5
Auditors' charges	52	10	0
Interest and discount	11	0	10
Interest on workmen's bonds	38	0	6
Company's subscription to sick club, doctor's club, and benevolent fund	156	2	3
Depreciation of freehold property, plant, and machinery, and patents	3,769	13	4
Balance, subject to further remuneration of the directors under Clause 90 of the articles of association, carried down	11,513	3	10
	£22,232	9	0
Contingent salaries to directors, as per articles of association	£1,286	9	4
Balance, available for dividend or reserve.....	10,226	14	6
	£11,513	3	10

Cr.	£	s.	d.
Gross profit for the half-year	21,804	12	10
Royalties receivable.....	200	0	0
Interest on invested reserve fund.....	51	4	8
Interest on other investments	168	16	6
Transfer fees	7	15	0
	£22,232	9	0
	£	s.	d.
Balance, profit, brought down	11,513	3	10

OSWESTRY ELECTRIC LIGHTING COMPANY, LIMITED.

The annual meeting of shareholders of the Oswestry Electric Lighting and Power Company, Limited, was held at Oswestry on Friday evening last. Mr. E. Bremner Smith in the absence of the chairman of directors, Mr. Wynne Corrie), presided.

The report, which was as follows, was taken as read: "The directors beg to submit the accompanying statement of accounts to December 31, 1895, duly audited. The balance of profit and loss account is £33 6s. 1d., which the directors propose to carry forward. Up to the present date the directors have received and accepted 24 applications for the supply of current, including three contracts with the Corporation of Oswestry. Mains have been laid in the streets included in the compulsory area, the supply to which will shortly be completed, and the directors are about to lay mains in Salop-road, Victoria-road, and Queen's-road, and invite further applications for the supply of current in private and business premises in these roads. The total capital expenditure to date is under the amount estimated in the original prospectus. With the purpose of still further popularising the use of the electric light, the directors have decided to reduce, as from January 1, 1896, the maximum price to 6d. per unit, for payment within one month from due date. All current used in any half-year beyond the amount which would be consumed during 635 hours (two hours per day throughout the half-year) at the highest rate of actual consumption at any moment during the half year will be charged at the rate of 3½d. per unit. With a view to the further development of profitable operation, the directors invite applications for a limited additional number of ordinary shares.—A. WYNNE CORRIE, chairman. March 12, 1896."

The **Chairman** had great pleasure in moving the adoption of the report.

Mr R. Lloyd seconded.

Mr. Williams asked a question as to the £510. 6s. 6d. in the accounts as the cost of the provisional order.

The **Chairman** said it seemed an extraordinary and extortionate thing that a small Company like theirs should have to spend over £500 to get an order to permit them to spend their own money. Some part of that sum, however, would have been saved if the Corporation of Oswestry had not opposed the order, an opposition for which they got nothing.

The **Chairman** said the retiring directors were Mr. Corrie and Mr. Robert Lloyd, who offered themselves for re-election. He proposed that Mr. Wynne Corrie be re-elected. He was sure the deep and anxious interest he had taken in the Company from its formation left them no other course but to re elect him. He had been the backbone and strength of the Company, always helping them in every possible manner, and he had very great pleasure in proposing his re-election.

Mr. Jones seconded the motion, which was agreed to.

On the motion of **Mr. Williams**, seconded by **Mr. Perks** Mr. Lloyd was re-elected a director, and he briefly returned thanks.

On the motion of **Mr. Perks**, Messrs. Williams and Nicholson were reappointed auditors.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Prague (Austria).—Tenders are wanted by June 1 for an electric lighting central station for the city of Prague. Application should be made to the Stadrath, Prague.

Paris.—On April 9 there will be a limited competition at the Hotel de Ville for the supply of eight standards for the electric lighting of the Quai de Jemmapes and the Quai de Valmy.

Elberfeld.—Tenders are wanted by April 20 for the supply of four engines and dynamos and 174 lamps, conductors, etc., for the Prussian State Railways. Address, die Königliche Eisenbahn-Direktion, Elberfeld, Germany.

Bucharest.—The Postal and Telegraphic Administration of the Roumanian Government desires tenders by April 18 for the supply of 60,000 porcelain insulators (three sizes) and 10,000 porcelain shackles, for the State telegraphs.

Vienna.—Tenders are wanted by April 15 for the supply of fastenings and tubes for an extension of the Vienna telephonic system. Particulars can be obtained from the Austrian Administration of Posts and Telegraphs, Section 13, Vienna.

Rathmines and Rathgar.—The Town Commissioners want tenders by April 20 for the electric lighting of the new town hall (about 250 lights, with engine and dynamo), and also for telephones and electric bells. Further particulars will be found in our advertisement columns.

Chiclana de la Frontera (Spain).—Tenders are wanted for the electric lighting of Chiclana de la Frontera, near Cadiz. The

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number of lamps required is 210 16 c.p., and the estimate is 15,000 pesetas (about £600) a year. The duration of the contract is 15 years, and tenders must be sent to the local authorities before April 6.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grange town, Yorkshire, to whom the plans, etc., must be sent by May 1.

Lima (Peru).—Tenders for the electric lighting of the city of Lima will be received up to June 1 next at the Peruvian Legation, 13, Comeragh-road, West Kensington, W. where applicants can obtain a memorandum explaining the local conditions. The tenders will be opened and considered by the Municipality of Lima, which reserves to itself the right of selecting that which is most approved or rejecting all if it thinks fit.

Edinburgh—Tenders are required by April 11 for the wiring of the police cells, Police-chambers, for the Lord Provost and Magistrates and Council. Specification, forms of tender, and plans of the building can be obtained at the office of the resident electrical engineer, 5, Dewar-place, Edinburgh, on deposit of £2 2s., which deposit will be returned on receipt of a bona fide tender. Tenders must be sent to Mr. Thomas Hunter, W.S., town clerk, by 10 a.m. on 11th inst.

Bedford.—The Electric Light Committee invite tenders for the supply and erection of the following plant: (Section A) one 240-b h p double-acting compound enclosed engine, (B) one 150-unit alternator, with stationary armature. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. T. S Porter, clerk to the Urban Sanitary Authority, Town Hall, Bedford, on payment of a fee of 5s. for each section. Tenders sealed and marked "Electric Lighting, Section A or B," must be delivered to the clerk by April 4.

Bradford.—The Corporation invite tenders for the erection of a building required for the new electricity station at the junction of Valley-road and Lionel-street in the borough. Plans and specifications may be seen and bills of quantities obtained, free of charge, on application to Mr. Thomas Barker, A.M.I.C.E., architect at his offices, 5, Bond-street, Bradford. An assurance must be given by each contractor that he pays to the workmen employed by him not less than the minimum standard rate of wages. Tenders, endorsed "Tender—Electricity Works," to be sent to Mr. W. T. McGowen, town clerk, Town Hall, Bradford, by April 8.

Derby.—The Electric Lighting Committee invite tenders for the supply and laying of low-tension cables and junction boxes in the borough. Plans may be seen on application to Mr. J. E. Stewart, engineer, Electric Lighting Station, Derby, from whom a printed form of specification, form of tender, and schedule of prices may be obtained on deposit of £2. 2s. (to be returned on receipt of a bona fide tender). Tenders on the prescribed form must be delivered with the specification attached, enclosed in a sealed envelope, endorsed "Electric Lighting—Tender for Cable," addressed to Mr. H. F. Gadsby, town clerk, Town Hall, Derby, by 12 noon on April 13.

Cardiff.—The Corporation require tenders for the construction, supply, delivery, and fixing of two boilers of the dry-back marine or water-tube type, each to evaporate about 6,000lb. of water per hour, and one 250 to 300 kilowatt direct-driven steam alternator. Specifications may be obtained on application to Mr. W. Harpur, M.I.C.E. borough engineer, Town Hall, Cardiff Sealed tenders, addressed to Mr. J L Wheatley, town clerk Town Hall, Cardiff, and endorsed "Tender for Electricity Works," must be left at his office by April 6 A fee of £1 1s will be charged for a copy of the specifications, which fee will be refunded on the return of the specifications, accompanied by a bona fide tender.

Wigan.—The Gas and Electric Lighting Committee require tenders for the following: (Contract No. 1) cast mains and connections, (2) wrought-iron tube and fittings, (3) brass tube and fittings, (4) lead pipe, (5) firing and charging shovels, (6) brooms, (7) wood troughing and covering, (8) galvanised stove pipe and connections, (9) bar iron. The contracts will be for one year, commencing 1st inst. and ending March 31, 1897. Forms of tender may be had from Mr. Jos. Timmins, engineer, Gasworks, Wigan. Tenders, sealed and endorsed with the names of the articles tendered for, a sample of which must accompany each tender, to be delivered to Mr. J. J. Charnock, town clerk, Town Hall, Wigan, by April 13.

Harrogate (Yorkshire).—Tenders are required by April 7 for an electric light installation (about 400 lights), including generating plant, also telephonic and bell installations at their Harrogate premises, for the proprietors of the Prince of Wales Hotel. Tenders to be sent in a sealed envelope endorsed outside "Tender for Electric Lighting, etc., Prince of Wales Hotel, Harrogate," and sent in under cover of second envelope, addressed to Mr. Walter Leake, consulting electrical engineer, 30, Victoria-buildings, Manchester. Copy of specification may be obtained from Mr. Leake on payment of £3. 3s. deposit, returnable on receipt of bona fide tender and return of specification. Plans to be seen at 30, Victoria-buildings, or copies may be obtained on payment of £1. 1s.

Egremont.—The Wallasey Urban District Council require tenders for the following requisites—viz.: (a) steam alternators, switchboard, and accessories; (b) high and low tension concentric cables; (c) transformers. Copies of the specifications may be obtained on application to the engineer, Mr. J H. Crowther, Gas and Water Works, Great Float, near Birkenhead. A charge of £2. 2s. will be made for copy of each specification, to be returned on receipt of a bona fide tender. Sealed tenders, on the form to be provided for the purpose, addressed to the chairman of the Gas and Water Committee, and endorsed "Tender for Steam Alternators, Switchboard, and Accessories," or any other contract, as the case may be, to be delivered at the office of Mr. W. Danger, clerk, Public Offices, Egremont, by 4 p.m. on April 6. Each contractor will be required to enter into a bond with approved sureties for the performance of contract.

Antrim.—The Commissioners for the Control of Lunatic Asylums will receive sealed tenders up to 10 a m. on May 1 for the supply and erection of an electrical installation at County Antrim Lunatic Asylum. The tender should be sent in a sealed envelope, endorsed outside "Tender for Electric Lighting, County Antrim Asylum," and addressed to the secretary, Board of Control, Custom House, Dublin, and should be accompanied by a separate sealed envelope, similarly addressed and endorsed, containing the detailed estimate. Forms of tenders, and copy of specification, which has been prepared by Mr. J. H. Greenhill, M I E E, will be issued on application to the office of the Board of Control of Lunatic Asylums, Dublin, on deposit of £3, which will be returned to all persons who have sent in bona fide tenders. Plans can be seen at the office of the architect, Mr. John Lanyon, Northern Bank-chambers, Royal-avenue, Belfast.

Manchester.—The Lancashire and Yorkshire Railway Company invite tenders for the supply of the following articles during 12 months ending April 30, 1897: copper rivets, washers, and tubing, signal and telegraph fittings, and signal, telegraph, and electric light wires. Further particulars and forms of tender may be obtained on application at the Stores Department, Osborne-street, Manchester. Contractors cannot be allowed to tender to their own patterns, nor can the company's patterns be sent away for inspection, all being sealed and exhibited at Osborne-street. Tenders, properly endorsed, and addressed to the Directors, must be lodged with Mr. C. W. Bayley, secretary, Hunt's Bank, Manchester, by 10 a.m. on April 6. Separate forms of tender will be provided for each contract; parties applying are therefore requested to state the particular contract for which they propose to submit tenders.

London—The Shoreditch Vestry require tenders for: (Section A) high-speed engines, electric generators, switchboards, instruments, and street lamps; (Section C) motor transformers and starting switches; (Section D) accumulator battery and stands. All to be delivered and erected complete at the Vestry's electric generating station, Coronet-street, Shoreditch, or in sub stations within the parish. Specifications, with forms of tender, can be obtained from Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of £3. 3s., which sum will be returned on receipt of a bona fide tender. Contractors are at liberty to tender for any one of the separate sections or for the whole of the contract, but the Vestry will not consider any tender for a portion only of any of the separate sections Contractors whose tenders are accepted shall enter into a formal agreement, under seal, with sufficient sureties, for the fulfilment of their respective contracts. Trade union rate of wages and hours to be observed. Sealed tenders, endorsed "Tenders for Contract No. 4," to be sent by 4 p.m. on April 14 to Mr. H. Mansfield Robinson, vestry clerk, Town Hall, Old-street, E.C.

RESULTS OF TENDERS.

Brussels.—Among the tenders for a long list of miscellaneous articles for the electric lighting of the city (specification No. 34) the lowest for lot 2 (dynamo brushes) was that of Messrs. C. Trimborn, Schaerbeck, 793fr.; lot 3 (mica plates), Messrs. Boty, Brussels, 220fr.; lot 7 (500 grammes of platinum wire), Messrs. R. Dürr; lot 8 (phosphor bronze bars and wire), Messrs. Felten and Guilleaume, 4 300fr.; lot 10 (arc lamps), Société d'Electricité, Bouckaert et Cie., 1 743fr.; lot 11 (incandescent lamps), Messrs. C. Trimborn, 845fr.; lot 12 (cables), Messrs. G Boty, 902fr. The other lots were of small amount.

Shoreditch.—The following tenders were received by the London County Council for the wiring and fittings of the new fire-engine station in Tabernacle square:

Russell and Lennard (accepted)	£173	15	0
Drake and Gorham	186	5	6
Crompton and Co., Limited	219	0	0
Pritchetts and Gold	228	0	0
A W. Jackson	248	10	0

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—The traffic receipts for the past week were £2,338.

Newcastle.—The National Telephone Company has just inaugurated a new central exchange in Pilgrim-street.

Glasgow.—The Tramways Committee of the Town Council have decided to discontinue lighting the cars by Froggatt's electric system, and to make experiments with a new oil lamp.

Dissolution of Partnership.—Messrs. W. O. Rooper and Tozer, of 11, Bridge street, Northampton, have dissolved partnership, and Mr. Rooper is carrying on business at Mill-street, Stafford, as he has done since 1884.

United Electric Wire and Telegraph Works, Limited—This Company has been formed, with a capital of £6,000, to carry on

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business as electricians, electrical and mechanical engineers, and suppliers of electricity.

London.—The County Council have sealed an agreement with the Post Office in respect of the maintenance of telephonic communication between the Whitechapel fire-engine station and the Tower-hill street station.

Barcelona Tramways Company, Limited.—This Company has issued a circular to the shareholders inviting subscriptions to 3,000 5 per cent. cumulative preference shares of £10 each, part of 10 000 recently authorised.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending March 29 amounted to £1,133 as compared with £1,002 in the corresponding week of the previous year, being an increase of £131.

Direct United States Cable Company.—The Board of the Direct United States Cable Company have resolved upon the payment of an interim dividend of 2s. 6d. per share, free of tax being at the rate of 2½ per cent. per annum, for the quarter ending March 31.

Langholm.—At a meeting of the District Committee of Dumfries County Council Mr Paterson, Clerkhill moved that steps be taken to get the telegraph extended to Eskdalemuir, through the parishes of Westerkirk and Eskdalemuir. The resolution was unanimously passed.

Wealdstone (Middlesex)—At the meeting of the Urban Council Mr. King, in accordance with notice, moved "that the Council proceed forthwith to consider the question of lighting Wealdstone and surrounding district by electricity." Mr. Balk seconded, but the matter was deferred.

Brixton (London)—The local branch of the Social Democratic Federation has passed the following resolution: "That this branch is of the opinion that in the interests of the parishioners and true economy, the electric lighting of Lambeth should be owned and controlled by the parishioners through their elected representatives."

City and South London Railway.—The returns for the week ended March 29 were £918, compared with £932 for the corresponding period of last year, being a decrease of £14. The total receipts for the half-year terminating as above were £12 656, compared with £12 648 in the same period of the preceding year, being an increase of £8.

Chelmsford.—At a meeting of the Town Council the Lighting Committee intimated that Messrs. Crompton and Co. had furnished them with plans relating to the proposed new electric station, which the town had been asked to take over, but owing to the absence of information no report could be presented Negotiations were still in progress

Aluminium Products Syndicate, Limited—This Company has been registered with a capital of £6,000 in £1 shares, to enter into an agreement, made March 20, between George Mahaffy and the Company for the acquisition of certain patents and trade marks, and to manufacture and deal in alumina, aluminium, ferro-aluminium, brass, etc.

York.—At a parish meeting held for the nomination of overseers, it was unanimously decided that at the next meeting, to be held on April 9, the question of the proposed expenditure of £15,000 to £20,000 as per Prof. Kennedy's report *re* the electric lighting of the city be taken into consideration, with a view to memorialising the City Council on the matter.

Peterborough.—The Lighting Committee are proceeding very hesitatingly with the electric light question. A special meeting has been held to consider the report of Mr. Gill on the probable annual expenditure and income of the proposed scheme, and the result is that the committee propose to again ask the ratepayers within the area whether they want the light and how many lamps they would require.

Southampton.—On the motion of the Mayor, the Town Council have appointed the following committee to deal with all matters relating to the acquirement and working of the electric lighting of the borough: The Sheriff, Aldermen Bone and Button, Councillors Cawte, Denness, Exten, Harfield, Lemon, Le Feuvre Spranger, Walton; and Alderman Tilling, when his connection with the electric light company ceased.

Chesterfield and Midland Counties Institution of Engineers. A general meeting of the members of the institution (Mr. Emerson Bainbridge, M.P., president) will be held in the Municipal Science College, Green lane, Derby, on Saturday, April 4, at 3 p.m. The next general meeting of the Federated Institution of Mining Engineers (Mr. G. A. Mitchell, president) will be held in London, from Thursday to Saturday, June 4, 5, and 6 1896.

Address.—We are advised that Messrs. Clarke, Chapman, and Co., Victoria Works, Gateshead-on Tyne, have, with Mr. Jos. Moore as their representative, opened an office at 73, Bridge-street, Manchester. Among the orders which the firm have on hand at present may be mentioned seven 400-light dynamos for Messrs. John Musgrave and Sons, Atlas Mills, Bolton, and a 1,300-light dynamo and 1,000-light installation for Messrs. Kelsall and Kemp, Rochdale.

Aberdeen.—On account of the increased demand for electric lighting in the city, the authorities have decided to purchase a new 300 h.p. engine and dynamo for the electrical station in Cotton-street at the price of £2,660. An outlay of £130 for an addition to the switchboards has also been agreed to. The chief extensions of mains recommended embraces the Queen's Cross district, where a large number of consumers are already assured; Golden-square and Rosemount-viaduct, as far as the Bon-Accord Free Church; and George street, as far as Craigie-street.

Dundee Institute of Architecture, Science, and Art.—The third ordinary meeting of the institute for the session will be held in Gallery No. 3 of Albert Institute, on Wednesday evening, April 15 next, at eight o'clock, when a few descriptive and critical remarks by the president, vice-president, and other gentlemen will be given on the drawings and testimonies of study to be exhibited. The president, Mr. R. Keith, will take the chair.

Leeds.—A full meeting of the Tramways Committee has been held, when the chairman (Mr. Hannam) and the deputy-chairman (Mr. Henry) reported the result of an interview they had had with Dr. Hopkinson respecting the electrical overhead tramway system proposed to be adopted on the route from the Canal-gardens, Roundhay, along Roundhay-road. North-street, down Briggate, and on Boar-lane to Kirkstall. After a lengthy discussion a resolution was passed recommending that Dr. Hopkinson be called in by the Corporation to superintend the construction of the proposed new electrical tramway.

St. Pancras (London).—The Vestry have constituted the London and South-Western Bank as bankers of the Vestry's electricity account, and have appointed the manager for the time being of the Camden Town branch as treasurer of the account. At the meeting of the Vestry held as we go to press, Mr. Hodgson has given notice to ask if the Vestry have power under the St. Pancras Electric Lighting Act, or other Electric Lighting Acts, to grant loans to the authorities of churches and chapels for the wiring of the buildings, such loans to be repaid by instalments, and, if so, to move a resolution thereon.

New General Traction Company, Limited—This Company has been registered, with a capital of £170,000, to adopt and carry into effect an agreement expressed to be made with Edwin A King to carry on the business of contractors for the construction and equipment of tramways and railways with electrical or other mechanical power, and, further, to acquire or enter into any contracts, concessions, or other grants for the making or purchasing of and working any railways, tramways, telegraph and telephone systems, electric or other lighting works, and to carry on the business of general contractors in any part of the world.

Public Building Lighting—Messrs. Drake and Gorman's Manchester branch has just completed the electric lighting of the new infirmary, Lancaster, with about 300 lights. This installation comprises a system of medical switchboards, telephones, and electric bells. They have also just finished a large installation of 1,300 lights for the new technical schools, Salford, to a specification prepared by Mr Charles Turner, the borough electrical engineer. Other installations in hand are the County Technical Schools, Stafford; County Infirmary, Stafford; Birkenhead Town Hall; and a country-house installation for Mr. Frank Hollins at Greyfriars.

Britannia Motor Carriage Company, Limited.—This Company has been registered, with a capital of £100,000, to adopt and carry into effect an agreement made between James Ashton of the one part and William Pennington, on behalf of this Company, of the other part, generally to acquire, develop, work, grant licenses in respect of, and turn to account in such manner as the Company shall see fit any patent, patent rights, etc., and to carry on the businesses of electricians electrical and mechanical engineers, cycle and motor manufacturers, carriage builders, machinists, fitters, founders, tube makers, metallurgists, etc, in all or any of their respective branches.

Camberwell.—The Vestry have adopted the report of the General Purposes Committee, which contained the following: "Your committee have had under consideration an application from the National Telephone Company for permission to lay three tubes, with the necessary manholes, to carry telephone wire cables under the pathway along the north side of the Old Kent-road from the parish boundary near the Old Kent-road station to the parish boundary at Upper Grange-road. The committee recommend that this application be granted on condition that the pathways are made good at the expense of the company to the satisfaction of the surveyor to the Vestry."

Philadelphia—A large electric locomotive, built for experimental purposes by the Baldwin-Westinghouse combination, has been shipped from the Baldwin Locomotive works, at Philadelphia, to the Westinghouse Electric and Manufacturing Company, at East Pittsburgh, where the electric equipment will be put in. This locomotive is intended for passenger service, and has two four-wheel locomotive trucks, each with a 6ft. wheel-base and 42in wheels It is designed for 1,000 h.p., and the weight on drivers is 120,000lb. A short line has been built near the Westinghouse Electric and Manufacturing Company's works, on which this locomotive will be tried.

Fulham (London).—At the Vestry meeting Mr. Sayer stated that the Special Committee *re* Electric Lighting reported that they received the report of Mr. F. Hastings Medhurst with reference to the adoption of the electric light in the parish in connection with a dust destructor, and had instructed the clerk to have 200 copies of the same printed They had accorded Mr. Medhurst a vote of thanks for the clear and thorough way in which he had presented his report, and recommended that a cheque be drawn for £50, the agreed fee. The recommendation was agreed to. Mr. Marks was elected to fill vacancy on the committee caused by the death of Mr. H. T. Harrison.

Middlesbrough.—A project is on foot to establish an electric tramcar system that will connect Norton, Stockton, Thornaby, and Middlesbrough. The existing interests of the Imperial Tramway Company in Middlesbrough would be acquired, a connecting line from Middlesbrough to Thornaby laid, and the Thornaby, Stockton, and Norton interests of the Darlington and Stockton

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Tramway Company acquired in those places. The District Fund Committee of the Stockton Corporation, however, object to the proposed overhead electric system, and if that Corporation will not grant the requisite permission the operations of the combination will be confined to Thornaby and Middlesbrough.

Tunbridge Wells.—Last week the borough electrician found it necessary to exercise his discretion and suspend the street-lighting. Owing to the rapid increase of private customers it may be found necessary to cut off the street-lighting altogether until the station is enlarged to the size originally contemplated, but which the shortsighted opposition of the Council prevented being carried out at the time. The mains are now to be extended into Camden-park and Sandrock-road. The latest hotel to adopt the light is the Clarendon, while three more houses on Broadwater Down are being added to the list. There are now over 7,000 lamps installed, which is really beyond the capacity of the present station. The builders have started the work of enlargement, and it will be pushed on as fast as possible.

Newmarket.—Speaking at an extraordinary general meeting of the gas company, the chairman (Mr. Robert Stephenson, J.P.) said there was a possibility of supplying the electric light in Newmarket without diminishing the consumption of gas. He was told on good authority that it was quite as cheap to use gas as coal, or even cheaper. At the present time they knew that several large houses in the town were lighted by electricity, and the motive power for driving the dynamos was supplied by gas-engines. If the Urban Council decided ultimately to provide the electric light themselves he had no doubt they would find that the best way would be to work in conjunction with the gas company and not in opposition to it. He did not think the electric lighting scheme could be a financial success.

Concerts.—Three very successful concerts have been given within the past week. The eighth annual smoker of the establishments of Messrs. Samuel Smith and Son, the Diamond Merchants' Association, the Diamond Merchants' Alliance, and Messrs. Gregory was held at the Freemasons' Hall on Saturday last, when a long programme was got through under the direction of Mr. Sam Wright, and a most enjoyable evening was spent by a very large company. The London central branch of the Electrical Trade Union also held a smoker at the Clerkenwell Town Hall on the same evening, at which there was a good attendance. On Tuesday evening last the City of London Electric Lighting Company gave a Bohemian concert at the Cannon-street Hotel, when a capital programme was presented to a crowded audience.

East Barnet.—At a meeting of the Valley Urban Council a letter was read from the National Telephone Company asking the Council for permission to erect ground poles along the Great North-road, for the purpose of connecting Barnet with the National telephonic system. The Chairman said, after the trouble they had taken to get the telegraph poles removed, he did not think the Council could agree to the erection of telephone poles along the road. Mr. Plowright said he could hardly agree with the chairman. In the case of the Post Office, they had plenty of money, but if they opposed the Telephone Company they would not put the wires underground, and Barnet might be deprived of telephonic communication with London for a long time. The Council, however, on the motion of Mr. Stutters, seconded by Mr. Valentine, refused the application.

Personal.—Mr. H. J. Dowsing has resigned his appointment as manager of the electrical heating and cooking department of Messrs. Crompton and Co., Limited, and has taken offices at 24, Budge-row, Cannon-street, E.C., where he will carry on the business of electric heating, adding several other special departments in the application of electricity. Mr. Dowsing has been nearly 15 years connected with Messrs. Crompton and Co., first on the outdoor staff, then London office manager, and finally manager of the heating department, which he established, the patents covering the processes bearing his name in conjunction with that of Mr. Crompton. Mr. Dowsing will be pleased to place his experience at the disposal of those thinking of adopting electric heating, and he will give special attention to the requirements of electric supply companies.

Shoreditch.—The Electric Lighting Committee of the Shoreditch Vestry have approved the specification for electrical plant as settled by the engineers, and tenders are now invited. At a meeting of the London County Council the Fire Brigade Committee reported as follows: "The new fire-engine station in Tabernacle square, Shoreditch, which is being erected by the Works Department, is nearly completed. As the station is within the area in which the Vestry of Shoreditch is empowered to provide electricity for lighting purposes, we consider it desirable that the public parts of the building, and the quarters of the officer in charge who is allowed light, should be lighted by electricity. We accordingly instructed the chief engineer to prepare a specification of the wiring and fittings necessary, and to invite six firms to tender for the work. We recommend that the tender of Messrs. Russell and Lennard be accepted, and that the solicitor be instructed to prepare a contract with them."

Guildford.—At a meeting of the Town Council a letter was received from the Board of Trade with respect to the system by which the energy was proposed to be supplied for the purposes of the Guildford Electric Lighting Order of 1894 A letter was also received from the secretary of the Guildford Electricity Supply Company giving notice that in one month it was the intention of the company to disturb the streets to lay the electric light mains. The mains would start at the old barracks, and would run under the pavement to North-street, up which they would run on both sides. The mains would, except at the top end, be laid on both sides of Spital-street and High-street. In Friary-street the main would run down the centre only, as would also be the case in Market-street. In other cases the mains would run under the pavement close to the houses 12in. below the surface, and in a V-shaped trough laid in with bitumen, and covered with boards. The matter was referred to the Paving Committee.

Lancaster.—The Electricity Committee have authorised the engineer to lay electric mains to houses in Dallas-road, and also to lay the necessary electric mains in China-lane, as soon as the street is ready for them. At the meeting of the Town Council Mr. Councillor Hall moved the adoption of the committee's minutes, and said they might take it for granted that the extension of the mains to China-lane would not be carried out until the property was erected. Mr. Councillor Bowness asked whether there had been any application made for the electric light in the China-lane and Dallas-place localities, or was it prospective. There seemed to be additional expenditure going on in connection with the electric light works. Mr. Hall said the main would be extended before the street was made simply to avoid laying a street and immediately breaking it up again. No doubt the property owners would take the light in China-lane, because it was quite as cheap and more effective than gas for shops. The minutes were confirmed.

Grimsby.—At a meeting of the Public Lighting Committee of the Corporation Mr. Alward proposed that the surveyor be instructed to draw out a rough sketch of what would be required, and that an approximate estimate of the cost be submitted at an early date. Mr. Crosby, in seconding, said that he would like the surveyor to bear in mind that they might have to provide for other lighting. Mr. Watkinson said that out of 28 boroughs using the electric light, 16 failed to make it pay. Mr. Barrett said that he had a list of boroughs that were using electricity, and his statement was nearly the opposite to that of Mr. Watkinson. He would suggest that, while they were considering the question of electric lighting, they should provide a refuse destroyer, which would supply them with the power, and at the same time destroy all the refuse of the town. It was ultimately decided that the sub-committee should choose one or two towns which had the electric light, so that a visit could be paid to them, and their plant be inspected.

Derry.—After the reading of a brief report from the resident electrical engineer (Mr. Christie) at a meeting of the Lighting Committee, Councillor Brown asked for some figures to indicate the expenditure incurred during the past four months in connection with the city electric lighting. The Chairman said that for four months and seventeen days there had been an outlay of £1,236 for the entire requirements in connection with the working of the station The proportion of interest on the loan for same period was in round numbers £500, and the cost for gas for same period £180, making £1,960 for the four months and seventeen days. To this might be added the expenditure in respect of two subsidiary schemes they had in connection with the original scheme spent £855 more than was borrowed. The subsidiary schemes, relative to the Guildhall electric lighting and the cattle pen electric lighting, cost £190 and £154 respectively. In regard to the working expenses it was but fair to say that the four months just elapsed were the severest for outlay in the year.

Oldham.—Major Marindin has held a Board of Trade enquiry concerning a proposal to construct an electric tramway from Oldham to Hyde, through Ashton, Audenshaw, and Denton. The British Traction (Pioneer) Company was represented at the enquiry by Mr. Sydney Morse and Mr. Sellon. The Town Councils of Ashton and Hyde and the District Councils of Denton and Audenshaw were also represented. Mr. Morse informed the inspector that the total length of the proposed tramway was seven miles six furlongs. The Lancashire County Council, the Limehouse Rural District Council Bardsley and Waterloo Parish Councils, Ashton and Hyde Town Councils, and Denton Urban District Council have all given their consent to the scheme. Mr. Chorlton, opposing the scheme on behalf of Audenshaw, said the company proposed to use a motive power which they knew nothing about from experience, and they (Audenshaw) thought it would not be an advantage. The Manchester Carriage Company already had communication with Audenshaw through a branch road.

Gulcher (New) Electric Light and Power Company.—The appeal in the matter of the Gulcher (New) Electric Light and Power Company, Limited, was argued before Lords Justices Lindley, Kay, and A. L. Smith on the 26th ult Before Mr. Justice Vaughan Williams, the liquidator applied for a declaration that Mr. James Murray was liable to pay calls on 300 shares of the Company. It appeared that Mr. Murray was the holder of some debentures which he agreed to exchange for preference shares on condition that 10s. per share was paid up on 37,423 shares. An allotment of the shares was made to him, and the liquidator sought to enforce that allotment. Mr. Justice Vaughan Williams held that the payment of 10s. per share on the 37,423 shares was a condition precedent to Mr. Murray's acceptance of the allotment, and dismissed the liquidator's application The liquidator now appealed, and after the case had been fully argued on his behalf by Mr. Gore-Browne, their Lordships, without calling upon Mr. Swinfen Eady, Q.C, who appeared for Mr. Murray, dismissed the appeal with costs.

Huyton (Lancs).—Major Cardew has held an enquiry into an application by the British Insulated Wire Company, of Prescot, for a provisional order to supply with electricity the districts of Huyton-with-Roby, Whiston, Rainhill, and Eccleston. Mr. Sydney Morse, for the company, stated that this was the second application. They supplied electricity for public and private lighting in

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Prescot; and, having laid down a considerable plant, they sought to extend the mains to the districts mentioned They were prepared to lay out £10 000 at once, without risk or cost to the ratepayers, to give them the benefit of the light if they wished for it. Mr. A. G. Steel, on behalf of the Huyton and Whiston Councils, objected to the granting of the application on the ground that no alteration had taken place since the first application was refused; and the evidence was not sufficient to warrant the consent of the local authorities. When a *bonâ fide* expression of desire for electricity was manifested, the Councils would take into consideration the advisability of applying for an order themselves. Witnesses were called on both sides.

Godalming.—The special committee of the Town Council have applied to the Board of Trade for a provisional order for electric light, which order has been made, and will be shortly introduced in a confirmation Bill to be passed this session of Parliament. The committee have instructed the engineer of Messrs. Fowler and Co, of Leeds, to report on eligible sites for an electric light station in or near the borough, and to furnish detailed plans and cost of works necessary to do the same. They recommend that the ex-Mayor and Mr. Page be added to the special committee for electric light and that the committee have power to add to their number in the future if they consider it advisable At the meeting of the Council Mr. Carpenter said he understood that when they passed a resolution to get a provisional order that was all, and nothing would be done for a year at least. He must oppose this action of the committee with regard to the engineer. Mr. Girdlestone said this was entirely without prejudice. There would not be a penny put on the borough for preliminary work, and Mr. Carpenter's observations were somewhat premature. The committee's report was adopted.

Bristol.—At their last meeting the Electrical Committee found to their great satisfaction that the income would meet the expenditure—cost of maintenance and repayment of loans with interest—without any call upon the general district rate. The lighting of the streets by electricity for the six months has cost £1,446, that charge including not only the current, but the maintenance of the lamps. The committee decided to accede to a request for extensions of the mains from College-road, *viâ* Cecil-road, to the Mansion House, and to Lansdown-road, Victoria-square, and to the end of Guthrie-road, where it joins Pembroke-road. The committee had before them a report of a sub-committee appointed to consider extensions of the central station and of the machinery and plant, and they decided to recommend the Town Council to apply for leave to borrow £75,000 additional capital. This recommendation will be presented at the April meeting of the Council, when it will be explained that it is not proposed to lay out the entire sum at once. There are now 510 private customers on the books, demanding 30,850 lamps, and of these 490 customers have already been supplied with lamps to the number of 28 134. The balance of customers are being supplied as rapidly as circumstances permit.

Hampstead (London)—Upon the recommendation of the Lighting Committee, the Vestry have decided to place a 300-kilowatt dynamo, with the necessary steam and exhaust pipes, etc, in the proposed additional buildings at the central station, and the engineer has been instructed to prepare the necessary specification in order that tenders for such plant may be invited as soon as possible The Vestry decided to lay mains for the supply of electric light to private customers in Lambolle-road, Downshire-hill, and Spaniards'-road, it being stated that one house in the last-mentioned road is being wired for 400 8 c.p. lamps. Mr. Dobbs asked when the report on the electric light undertaking promised some time ago by the vestry clerk, would be ready. The Vestry Clerk replied that he had not yet been able to get all the required items, but he hoped to have the report ready before the next meeting of the Vestry. Replying to Mr. Randall, the Engineer said that the failure of the electric light in England-lane last Saturday night was caused by a breakdown of the low-tension cable on Haverstock-hill. Mr. Farmer asked when the work of lighting the High-road, Kilburn, by electricity would be taken in hand. If they were going to wait for Willesden, they might have to wait for ever. The Chairman said that at present the Lighting Committee had no reference on the subject before them.

Newington (London).—Major Philip Cardew, R.E, has held an enquiry on behalf of the Board of Trade with reference to the provisional order which is being promoted by the Vestry, with the object of obtaining powers under the Electric Lighting Acts in that parish. The London Electric Supply Corporation oppose the order on the ground that they were authorised in 1889 to supply the parish, and that they had since executed the necessary works and made the necessary arrangements for supplying the parish with electrical energy. The County of London and Brush Provincial Electric Lighting Company, Limited, and the Newington and Walworth Ratepayers' Association have also given notice of objection. The Vestry's reply to the petition of the latter body commences by doubting the existence of such a society. There is every reason to believe, says the Vestry, that the opposition arises from purely interested and party motives. With regard to the signatures, the Vestry points out that 464 of the petitioners (1,451 in all) are not entitled to a vote, their names not being on the parochial register. There are 1,204 householders in the compulsory area, but only 173 had signed the petition. The Vestry claims that electricity can be supplied by them without being a burden on the ratepayers. In fact, if the Vestry obtained the provisional order they would have to satisfy the London County Council that the installation to be proposed was a well-considered scheme, and one which would not inflict a burden upon the ratepayers, before any loan would be authorised.

Cheltenham.—The Town Council having applied to the Local Government Board for sanction to borrow £25,000 for purposes of electric lighting, Major-General H. D. Crozier, R.E, has held an enquiry at the Municipal Offices. There were present, among others, the town clerk (Mr. Brydges), the borough surveyor (Mr. Hall), and the electrical engineer (Mr. Kilgour). The Town Clerk explained that the application was made by the Corporation under the provisions of the Cheltenham Electric Lighting Order, which was put in force in 1893 and 1894 Application was made for a loan of £16,000 to carry out the necessary works, which were opened on March 16 1895. It was found in the course of the works that some alterations and additions would have to be made, and the expenditure exceeded the estimate by about £880. As time went on the demands for the light became so great that it was found necessary that further plant should be established, and that it was found necessary to make extensions without delay. In order to provide for this, application was made in August, 1895, to the Local Government Board for a further loan of £10,000. Now only, after seven months, that application was being considered. A considerable portion of the money had been spent, and it was found that in order to carry out the works that would be necessary next winter a further £15 000 would have to be raised. It was therefore decided to include both applications in the same enquiry.

Appointments Vacant.—The Commissioners of the Hackney Public Baths require an engineer and electrician at the baths. He must be a thoroughly experienced man. Salary £156 per annum. He will not be entitled to receive any pension or superannuation allowance. Applications, in candidates' own handwriting, with copies only (which will not be returned) of not more than three testimonials of recent date, marked on the outside "Application for the Appointment of Engineer and Electrician" should be sent to Mr. Geo Grocott, clerk, at the Town Hall, Mare-street Hackney, not later than 12 o'clock noon on Thursday, April 16, 1896. Personal canvassing not allowed. Selected candidates will, prior to the election, be required to attend the Commissioners and due notice will be given to them when their attendance is required.—The West Ham Town Council invite applications for the appointment of electrical engineer. Candidates must have had previous experience in a similar appointment with a company or corporation supplying electricity under parliamentary powers, and be competent to design and supervise the construction of the generating station, plant machinery, appliances, and cables necessary to generate and supply electricity for public and private lighting on the high-tension alternating system. The gentleman appointed will be required to devote his whole time to the work. The salary will be £300 per annum. Forms upon which application must be made may be obtained at the office of Mr. Fred. E. Hilleary town clerk, Town Hall, West Ham, and applications must reach him by 5 p.m. on April 8. Canvassing members of the Council is prohibited.

Hull.—The Electric Lighting Committee have had under consideration a report from Mr. A. S. Barnard, borough electrical engineer, dealing with the proposed extension of the electric lighting undertaking, and suggesting that distributing mains be laid in the following: Spring-bank, 1,070 yards, both sides; Beverley-road, 1,600 yards, ditto; Anlaby-road, 1,500 yards, ditto; Hessle-road, 1,000 yards, ditto; Walker-street, 600 yards, one side; Commercial-road, 400 yards, ditto; Waterhouse lane, 200 yards, ditto, and 100 yards, both sides; Porter-street, 500 yards, both sides; Midland-street, 100 yards, ditto; Osborne-street, 500 yards, ditto; Charles street, 450 yards, ditto; Waterloo-street. 650 yards, one side; Brook street, 400 yards; Wright-street, 400 yards; Queen's-road, 500 yards; Princes avenue, 1,100 yards; Derringham-street and Argyle street, 1,100 yards; Boulevard, 1,000; Brunswick-avenue, 400 yards; Fountain-road, 400 yards; and Park street. 800 yards—all on one side of the streets only. The total extension of mains amounts to 14 670 yards, which will serve the greater portion of the town. In addition to the streets enumerated, it may be desirable to lay distributing mains in East Hull to the extent of 2,650 yards, Witham, Holderness-road, Williamson-street, Drypool square (Upper Union-street), having 500 yards each, and Hedon-road, 650 yards. The extension would, however, depend upon the probable demand for current, for unless some such guarantee was forthcoming the expenditure would scarcely be warranted. The committee are not likely to have any difficulty in securing a suitable site for a station, as the Corporation have two or three plots suitable for the purpose

Cardiff.—Mr. G. W. Willcocks, M.I.C.E., Local Government Board inspector, has held an enquiry respecting the application by the Corporation to borrow £12,500 for the extension of the public electric lighting. There were in attendance Mr. J. L. Wheatley (town clerk), Mr. W. Harpur (borough engineer), and Mr. Appleby (electrical engineer). The Town Clerk explained that the town and population of Cardiff had rapidly increased and were increasing, that the Corporation had already borrowed £43,385 for electric lighting, and that the further sum of £12,500 was required for additional engines, boilers, and other plant, additions to the electric lighting station, and extension of the mains. The Borough Engineer also gave evidence, and said that since the initiation of the lighting in December, 1894, there had been an increased demand by the public, and this had really been in excess of the anticipations of the Corporation. At present they were supplying 10,000 8-c.p. lamps, and applications had been received for 2,500 more, which they could not supply because they had not the power. They therefore required additional buildings and plant, and unless that were done by next winter the present plant would not be capable of supplying the light. The proposed outlay would provide for an additional 10,000 8-c.p. lamps. Mr

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Appleby also gave evidence as to what would be required. There was no opposition. The inspector will report in due course At a meeting of the Tramways Committee of the Corporation, the chairman (Mr. James Tucker) put before the members a scheme for the purchase of the tramways, which, he said, he had reason to believe would be accepted by the tramways company. It had been arranged—provisionally, of course—that several extensions should be made, and that electrical power should be used whenever the Corporation thought it advisable and were able to supply that power. In answer to Mr. Jenkins, the Chairman stated that the company were quite willing to adopt electricity when the Corporation thought it advisable Eventually a sub-committee was appointed to consider the details.

Mevagissey (Cornwall)—This town, which is almost buried among the hills on the south coast of Cornwall, and which has a population of about 2,300, is now lighted by electricity, the inauguration ceremony having taken place. To the Electricity Committee of the Parish Council is chiefly due the credit of installation. Through their exertions an electric lighting company was formed, with a capital of £1,500; and the contract for the installation was placed with Messrs. Veale and Co, electrical engineers, of St. Austell, who carried out the work in six weeks. The company have agreed with the Parish Council to light the streets for £48 per annum. The central station is situated close to the new quay, just outside the inner harbour, which enables the coal required for the engine to be landed direct from the ship into the store. On this site has been erected a plain stone building of one storey, with corrugated iron roof. Internally the premises are divided into three sections, for the engine and dynamo, accumulator batteries, and stores. The engine, manufactured by Davey-Paxman, of Colchester, is a compound under-type, semi-portable, with locomotive boiler, and of 12 h.p. nominal capacity, but capable of developing 30 h.p. It drives a Crompton 200-ampere 130-volt dynamo. Although the dynamo is capable of supplying all the electricity required for lighting the town direct, it is supplemented by a set of accumulators consisting of 60 Epstein cells, with a storage capacity of 360 ampere-hours. These are placed in a separate room adjoining the engine-house. When working at full pressure the dynamo is capable of charging both the mains and the accumulators at the same time. By means of a lever on the switchboard the strength of the current can be regulated. Five miles of mains have been laid, extending to all parts of the town. The mains are pure copper wire, supported on insulators, laid in creosoted wood conduits under the surface of the ground. They are capable of supplying 400 16-c.p. lamps at the same time. The streets are illuminated by 32 lamps of 16 c.p. and two of 32 c.p. The street lamps are bell-glass globes, 10in in diameter, suspended from plain iron brackets projecting from the walls of the buildings to which they are fastened. Over each light is an inverted opal shade, which acts as a reflector. It is intended to place a large lamp of 100 c.p at the pierhead, and 11 16-c.p. lamps round the harbour. As yet no private consumers have been supplied, but orders are rapidly coming in The charge to private consumers will be at the rate of 6d. per Board of Trade unit, which is equivalent to gas at 4s. per 1,000ft. For the present it will only be necessary to work the engine and dynamo twice a week, the accumulators storing sufficient electricity to light the town the rest of the week. The installation has been carried out under the supervision of Mr. F. Hedley for the contractors.

Bedford.—At the meeting of the Urban Council the first balance-sheet in connection with electric lighting was submitted as follows: Capital account—expenditure to December 31, 1895: to buildings, £3,526. 3s 4d.; machinery, £5 554. 13s; mains, including cost of laying same and paving, £5,483 12s. 8d.; transformers, £536. 5s.; meters, £530. 19s. 5d.; electrical instruments, £535. 3s. 8d.; legal charges, £268. 1s. 6d; engineer's commission, £793. 19s. 4d.; lamp columns (public lighting), £41. 8s. 1d.; miscellaneous, £66. 9s.—total. £17,336. 15s.; 1895—December 31, balance in treasurer's hands, £4,677. 7s. 6d.—grand total, £22,014. 2s. 6d. Receipts to December 31, 1895: by amount raised by loans, £22 000; miscellaneous, £14 2s. 6d.—total, £22,014. 2s. 6d. Revenue account—Expenditure to December 31, 1895: to fuel, including all expenses from December 6, 1894, to December 31, 1895, £399. 4s. 7d; oil, waste, and engine-room stores, £70. 14s. 5d.; wages at generating station, £290. 15s. 9d.; repairs, etc., £4. 3s. 8d.; wages of linesman, £43. 8s.; lamps (public lighting), £1. 4s. 6d.; rates and taxes, £39. 14s. 6d.; engineer's salary, £157 16s. 8d.; stationery, £4. 14s. 5d.; insurance, £20. 12s. 9d.; rent of land belonging to authority appropriated for electrical purposes, £20; balance carried to net revenue account, £90. 9s. 7d.—total, £1,142. 18s. 10d. Receipts to December 31, 1895: by sale of current from December 6, 1894, to December 31, 1895 at 6d. per unit, £1,114. 18s. 4d.; rental of meters, £28. 0s. 6d.—total, £1,142. 18s. 10d. Net revenue account — Expenditure to December 31, 1895: to County Fire Office—first instalment of loan of £12,000, £480; County Fire Office—one year's interest at 3¼ per cent, £390; total, £870 Receipts to December 31, 1895: by balance brought from revenue account, £90. 9s 7d.; balance, £779. 10s. 5d. — total, £870. Alderman Richards said this was the first annual statement the committee had to lay before the Council, and they thought that it was a satisfactory statement They would see that a balance of £90. 9s. 7d. was brought down towards the instalments and the interest. They had made such satisfactory progress with their customers that he felt they were justified in anticipating a very large increase in their income for another year. They began in December, 1894, with, of course, a small number of lamps connected and few customers. They began before the machinery was in proper order, but managed to supply their customers, who had gradually crept up in numbers. On June 30, 1895, they had 65 customers and the equivalent to 3,000 8-c p. lamps connected with the mains. On December 31 last there was a further increase of 109 customers, and the estimated number of 8-c.p. lamps was 4,105 All this was carried out on their first installation At the present time they had 5,240 lamps connected up, with 1,100 on order, and they anticipated a larger increase during the coming year. Taking a modest estimate they anticipated that at the end of the year there would be 8,000 8-c.p lamps, and if such was the case they would undoubtedly be coming very near to a balance, if they did not have a profit. The electric light was here, and it had come to stay, and it would undoubtedly increase. They had their plant and staff, and to a certain extent they had their customers. The expense would remain about the same, but for every unit of electricity they produced the cost of production would be 1d. per unit. So the moment they got another customer who wanted a unit of their electricity that gave them a profit, and that was why the committee anticipated a balance at the end of the year. When they visited the Board of Trade they were told that undoubtedly the plant for the generation of electricity had got almost up to the point of perfection, and that with slight alterations it would be inexpensive; that the royalties were falling off the lamps, and that everything that could be done to improve the lamps would be done at as little cost as possible. There was another matter with regard to street-lighting. He believed that Bedford was the only Corporation that had gone so thoroughly in for incandescent street-lighting. Many people had asked him why they did not have the arc lighting. He said now, as he had said from the first, that the expense of arc lighting was too great. They were satisfied they would get all they required with incandescent lamps, and he believed Bedford was the only borough in England where street-lighting was carried out on the three-wire system He moved the adoption of the balance-sheet, which was seconded by Mr. Taylor and carried, a vote of thanks being also given to the engineer, Mr. Johnson. The committee recommended that the common seal be affixed to the following contracts—viz., Siemens Bros and Co., Limited, for the construction of a switch-board, including the supply of necessary instruments, £400; W. Bradley, for the supply of 150 additional cast-iron lamp standards and fittings, £374. 5s. This was agreed to.

Belfast.—The electric lighting plant at Purdysburn Asylum consists of two dynamos nine kilowatts each (90 amperes at 100 volts), by the Electric Construction Company. They are direct coupled to Bumsted and Chandler high-speed engines, running at 460 revolutions per minute. The dynamos can be worked up to 130 volts at a reduced current when required for battery charging The battery consists of 56 K 17 type E.P.S cells with a capacity of 275 ampere-hours at a 55 ampere discharge rate. Two Cornish boilers (Penman) supply the steam for the engine, pumps, and washing department. A ring steam-main is provided so that steam can be taken two ways from either boiler, and steam-traps are connected to the main where required. The feed pumps and pipes are in duplicate, and can be worked singly or in parallel on either boilers or tanks. The main switchboard is by Crompton and Co., and is provided with battery regulator, automatic switches, and the usual instruments, shunt resistance switches, etc., and all arrangements for running the machines in parallel. The wiring is done throughout on the distributing-board system. There are no joints in the work, and all the lamps are wired back to the sub-distributing boards. The switches are key type, and can only be operated by the attendants The washing machinery is worked by electric motors Plans and specifications for the work were prepared by Mr. Victor A. H. McCowen, who acted as consulting engineer for the Board of Control, and the work was carried out by Messrs W. H Drennan, Belfast. Mr. Andrew Nance, manager to the Belfast Street Tramways Committee, has published a report made by him to the directors as to the working of electrical tramways on the Continent. He draws attention to the fact that his report, which was made last September, is almost identical in its conclusions with the report of the Corporation traction deputation, although arrived at from an entirely opposite point of view. The conditions that the committee annexed to their report seemed to him to be reasonable and such as the company could assent to with verbal alterations of no great importance. A special meeting of the Corporation has been held for the purpose of dealing with the tramways company's order under the Tramways Acts. The Town Clerk (Sir Samuel Black) said the order would, of course, have to be approved of by the Corporation, and then go forward to the Privy Council for confirmation. The Corporation, no doubt, were aware that the tramways company had a Bill in Parliament to empower them to use mechanical traction, and the Council also had, through the Press that morning, and directly, seen a copy of the report of the deputation upon the question, and it would be for the Council to deal with that report and say whether or not they would permit the company to use electricity on their lines. In any case the order would have to be modified in several respects, and he was not yet in a position to settle the order, even supposing the Corporation agreed to the proposal of doubling the lines, in any such way as would be satisfactory to the Corporation, the tramways company, or himself, and the wisest thing for the Council to do would be to adjourn the meeting for a fortnight or so, so that he could consider the question, and bring it properly before the Council, and let them decide whether electric traction should be allowed or not, and also to allow the tramway company to consider the report that had been made by the deputation. Mr. A. H. Bates (instructed by Messrs. C. and J. Black) said he appeared on behalf of the tramways company. He did not know whether the town clerk was fully aware of the conditions under

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which the tramways company were prepared to accept their approval, because he thought the Council would be of the opinion that those terms were of such a character as to entirely disarm all opposition, and also to render the question of the adjournment unnecessary. The works authorised by the Order in Council were simply in the way of doubling the existing system. There was a reference in the Order in Council to mechanical power, but the Order in Council did not absolutely authorise the use of the mechanical power. Under those circumstances the only possible objection to the application before the Council appeared to be the question of whether or not it would be convenient in the public interest to have these lines doubled in certain streets. The tramways company was prepared to get rid of that question entirely by these terms. They were willing to accept the approval of the Corporation, subject to the conditions that they exercised their power in reference to any street, no matter what its dimensions might be, subject to the absolute veto of the Council. The Order in Council would be really reduced to enable the tramways company, as a corporation, to do certain things, but it would give them no power whatever against the Corporation. The Corporation would have it in their power to say whether, in reference to a single street, they would exercise their powers, and, of course, they would say what terms. The only other possible ground for adjournment was that the town clerk had not got time to consider the alteration. The company only asked for an Order in Council subject to such alterations as they might be advised by the town clerk to make, and seeing that the application had assumed that form he did not think there was any occasion for adjournment. After some discussion, further consideration of the question was adjourned. At a meeting of the Electric Committee the engineer reported satisfactory working, and the accountant submitted a statement of accounts, showing the result of the past year's working to have been a profit of about £300, which was considered fairly good for the first year.

PROVISIONAL PATENTS, 1896

MARCH 23.

6374. **Improvements in electric traction** Deeiré Korda and Anthony George New, Palace chambers, Westminster.

6397. **Improvements in conduits applicable for wires for conveying electricity.** John James Bate, 6, Lord-street, Liverpool

6407. **Method and apparatus for electrically coating articles with zinc.** William Stepney Rawson, 21, Greycoat-gardens, London.

6423. **Improvements in electric switches.** William Henry Dingle and John Mackenzie Urquhart, 23 Bucklersbury Mansion House, London.

6437. **Improvements in and relating to current collectors for electrically-actuated tramway vehicles with underground feed** Henry Harris Lake 45, Southampton-buildings, Chancery lane, London. (Union Electricitäts-Gesellschaft, Germany.) (Complete specification.)

MARCH 24.

6477. **An improved cord grip for electric light fittings.** George Owen Donovan, 49, Hartismere-road, Fulham, London.

6481. **Improvements in apparatus for supplying electricity to electrically-propelled vehicles on railways and tramways** Auguste Mégroz, 46, Lincoln's-inn fields, London. (Complete specification)

6487. **Improvements in controllers for electric motors** James Devonshire, 70, Chancery-lane, London. (Edward D. Priest, United States) (Complete specification)

6504. **Improvements in electrically illuminating devices for advertising purposes** Julius Lengyel and Armin Schlesinger, 45, Southampton-buildings, Chancery-lane, London.

6510. **An improvement in electric arc lamps** James Brockie, 28, Southampton-buildings, Chancery-lane, London.

MARCH 25.

6524. **Improvements in electric counters** Frederick George Robinson, 15, Water street, Liverpool.

6549. **Carbon-holder for dynamo rubbers.** François Joseph Head, 8 Rue des Princes, Brussels.

6579. **Improvements in telephonic apparatus** Alfred Graham, 46, Lincoln's-inn-fields, London.

MARCH 26.

6606. **An electric cyclometer.** Thomas Gill Smith, 29, Poland-street, London.

6625. **A new or improved holder for telephone receivers** Arthur John Fippard, Upper-terrace road, Bournemouth (Complete specification)

6692. **Improvements in or connected with fusible electric cut-outs.** Alexander Bewicke Blackburn and Wilfred L. Spence, 47, Lincoln's-inn-fields, London.

MARCH 27.

6732. **Improvements in and connected with advertising devices operated by an electrical current.** John Hillary Collings, 73, St. Stephen's-road, Upton Park, London.

6751. **Improvements in or appertaining to carbons for electrical purposes.** William Phillips Thompson, 6, Lord-street, Liverpool. (Albert Lessing, Germany.)

MARCH 28.

6864. **Improvements in short-circuiting or safety devices for overhead electric conductors.** George Alonzo Jewett, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1890.

13635 **Electric welding.** Thompson. (Coffin.) (Second edition.)

1892.

14239. **Electric meters.** Hookham. (Second edition.)

20214. **Electrolytical apparatus** Boult. (Knöfler.) (Second edition)

1894

7801. **Electrolytical apparatus** Kellner. (Second edition.)

23697. **Electrodes.** Woakes

1895

3085. **Electric gaslighting device.** Jahnson. (Second edition.)

4476. **Electric medical appliances.** Braun and Sharman.

4660. **Electro-deposition of iron on copper, etc.** Hiorns.

5515. **Electric measuring instruments** Crompton.

8507. **Electric cut-outs.** Jeckell.

8573. **Electric cables.** Smith and Granville.

8664. **Arc lamps** Crompton and Pochin.

8727. **Electric switches.** Siemens Bros. and Co., Limited, and Lauckert

8728. **Secondary voltaic batteries.** Rhodin.

8905. **Galvanic batteries.** Menges.

8914. **Chloride of lead for electric batteries, etc.** Davis.

8994. **Arc lamps.** Jandus.

9286. **Electric switches** Hopkinson.

10029. **Electric lamps.** Singer and others

10792. **Galvanic batteries.** Elliott.

13636. **Electric signalling, etc.** Crandall.

19839. **Dynamo-generators or motors** De Puydt and Poncin.

1896.

156. **Regulating gas or electric light to railway coaches.** Proctor and Gill.

475. **Electric accumulators** Bersey.

1198. **Electric railways.** Darley.

2717. **Electric switches.** Royce and Claremont.

2767. **Telephonic systems.** Bennett and Somerville.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1⅞-1⅞
—— Non. Cum , 6 per cent. Pref.	2	1⅜-1⅞
—— 4½ per cent. Debenture Stock	100	110-113
Charing Cross and Strand	5	7½-7⅞
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7½-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½ 2⅞
Edison and Swan United Ordinary	3	1⅝-1⅞
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	1⅛-1⅜
—— 7 per cent. Cumulative Pref.	2	2⅛ 2⅜
Elmore's Copper Depositing	2	⅝ ¾
Elmore's Wire Company	2	⅝ ¾
Fowler-Waring Cables	5	1-2
W. T. Henley's Telegraph Works, Ordinary	10	16½-17½ xd
—— 7 per cent. Preference	10	16½-17½ xd
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	3½-3¾
—— 7 per cent. Preference	5	7⅞-8¼
India Rubber and Gutta Percha Works	10	20-21
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge Ordinary	5	8½-8⅝
—— 6 per cent. Pref.	5	7½-7
Liverpool Electric Supply, Ordinary	5	7⅝-7⅞
Liverpool Overhead Railway	10	13⅞-14½
—— 5 per cent. Pref.	10	16⅜-16¾
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	⅝-¾
Metropolitan Electric Supply	10	13-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	119-120
National Telephone, Ordinary	5	6⅞-7
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17⅛
—— 5 per cent. Non. Cum. Third Pref	5	6⅜-6¾
—— 3½ per cent. Deb. Stock	100	106-109
Notting Hill Company	10	8⅞-9¼
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8⅞
—— £4½ shares	4½	7½-7⅞
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4⅞ 5½
St. James's and Pall Mall, Ordinary	5	9⅜-10½
—— 7 per cent. Pref.	5	9⅜-10½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	4	6½-6⅞
Westminster Electric Supply, Ordinary	5	9⅜-10
Yorkshire House-to-House	5	7-7½

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NOTES.

French Association.—This year's meeting of the French Association for the Advancement of Science has been held at Tunis, and has just closed. There were about 400 visitors. Next year's meeting will be held at St. Etienne, and the 1898 meeting will be at some Channel port, probably Boulogne, which is within easy reach of the British Association's meeting at Dover.

Testimonial.—Mr. W. Bathurst, who has held the post of assistant engineer at the Hampstead electric lighting station since the date of its opening, was last Saturday presented by Mr. E. Sayer with a testimonial in the form of a leather writing case, subscribed for by the indoor staff. Mr. Bathurst is leaving for the Cape of Good Hope at the end of next week. Mr. C. O. Bastian, who lately tendered his resignation, will also be leaving Hampstead in the course of the next fortnight.

Acetylene.—According to the *Moniteur Industriel*, the tramcar of the Compagnie des Tramways de Paris which has been fitted experimentally with apparatus for lighting by acetylene manufactured from carbide of calcium has been running regularly since February 27. The light is said to be extremely good and steady, and the result is considered satisfactory from the point of view of expense, though at present the precise amount of the daily consumption of calcium carbide is not known.

China.—Speaking of the growth of electric lighting in Shanghai, the *China Gazette* says a couple of years ago there were only about seven miles of streets lighted by electricity, for which 60 arc lamps were quite sufficient, and there was not a single incandescent lamp in or around Shanghai. Now it appears the electrical department of the Municipal Council runs 140 arc lamps, lighting some 15 miles of streets, and there are about 43 miles of line wire laid, in addition to 6,100 incandescent lamps of 8 c.p. each, for domestic purposes.

Budapest Exhibition. — In connection with the Hungarian millennial celebration and exhibition an electric underground railway has been constructed at Budapest, and was opened on Tuesday last in the presence of the Burgomaster and a number of high officials. The railway is about two miles long, and is a remarkable example of underground railway engineering. It runs from the Gisela Platz to the exhibition, so that passengers will be conveyed from the centre of the town to the grounds of the exhibition for a trifling fare.

Municipalising Telephones. — According to the British consular reports, the authorities at Amsterdam have been for some time anxious to put in force a policy of municipalisation so far as concerns the undertakings of public supply companies. It appears from the same source that the Amsterdam Telephone Company, to which at first very unsatisfactory terms were offered for the purchase of their installations on the expiration of their concession, eventually succeeded in obtaining acceptable terms for the transfer of their business to the municipality, but the attention of investors is called to the risks run by companies based on municipal concessions.

New Trade Paper.—A new sixpenny monthly has made its appearance under the title of "Aluminium and Electrolysis." As its name denotes, it is devoted to the production and use of aluminium. After an introductory note, mainly historical in character, the March issue has notes on the various purposes for which aluminium is adapted, and on the employment of British capital in its manufacture, with special reference to the British Aluminium Company. There are articles on the use of aluminium for cooking utensils and on "ferro-aluminium," and a quantity of miscellaneous notes, etc. The new paper is published at 3, Bolt-court, E.C.

The Crystal Palace Carriage Show.—In connection with the Crystal Palace International Horse-Drawn and Horseless Carriage and Roads Locomotion Exhibition, to be opened on May 2, there will be a chronological collection of cycles, marking the birth, rise, and development of the cycle. Those in possession of, and willing to lend specimens, should communicate at once with Mr. H. Hewitt Griffin, Putney. Mr. Cumming Macdona, M.P., has written to the *Times* reviving the controversy on the proper name for a self-moving cart. Mr. Macdona wants them called "automovers." If one begins a word in Greek, surely it is better style to finish it in the same language.

Edinburgh Observatory.—The new Royal Observatory at Edinburgh was formally opened on Tuesday by Lord Balfour, Secretary for Scotland. Lord Crawford and Sir R. S. Ball also took part in the proceedings. The new observatory contains a 15in. refracting telescope in addition to the old 2ft. reflecting telescope, and among the instruments in the building are the great Dun Echt electromagnet, which is said to be the most powerful in the world; a chronograph, with electrical appliances, which records the exact moment of every observation in every part of the building; and the carefully protected clock, connected by wire with Greenwich, which fires the daily time-gun at Edinburgh Castle and drops the time-ball on the Nelson monument.

Rontgen Radiations.—The theory of the new radiations still stands where it did. As Lord Rayleigh put it, in remarking that notwithstanding innumerable repetitions of experiments we had not yet got much nearer to understanding the phenomena, the difficulty lies in the impossibility of applying the ordinary methods of analysis. Almost nothing can be done with rays which we can neither reflect nor refract nor pass through doubly refracting crystals. It may, however, be worth recording that, according to an article in *L'Elettricità* of this week, it has been discovered that ordinary sunlight that has suffered abnormal refraction by fuchsine contains components which appear to have the power of passing through cardboard, leather, wood, or black cloth.

The Paris Telephone. — It is stated that the telephone service between London and Paris has been so successful that the postal authorities are about to lay a second cable across the English Channel to meet the increasing demand for the use of the wires, and that the work on the land wires is now being proceeded with on both sides of the Channel. The second cable is to be laid from Lydden Spout, about two miles to the west of Dover. The land wires of the present system terminate at St. Margaret's Bay, from which point the cable starts. At present the wires are only used between London and Paris, but it is stated that when the second cable is laid Manchester and Liverpool and some other large centres are likely to be directly connected.

Society of Arts.—The next course of Cantor lectures will be delivered by Prof. Henry A. Miers, M.A., on Monday evenings, April 13 and 20, the subject being "Precious Stones." The lectures will close with some remarks on artificial stones. Mr. James Swinburne will deliver a course of Cantor lectures on "Applied Electro-Chemistry" on Monday evenings, April 27, May 4, 11, and 18. Among the papers arranged for forthcoming meetings is one on April 22 on "The Perfected Photochromoscope and its Colour Photographs," by Mr. F. E. Ives. Papers at subsequent meetings

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will be read by Captain Abney, on "Orthochromatic Photography;" by Mr. Hudson Maxim, on "High Explosives and Smokeless Powders;" and by Mr. E. W. Moir, on "Tunnelling by Compressed Air."

A Cotton Mill Plant.—Much attention is being given in the United States to the utilisation of water power in generating current both for general supply and in the case of individual enterprises. To the latter class belongs the electrical equipment of the extensive cotton mills of the Pelzer Manufacturing Company, which is now nearing completion. The power is derived from Victor turbine waterwheels, driving three 750-kilowatt three-phase generators, wound for 3,300 volts. The waterwheels turn at a speed of 164 revolutions per minute. The current generated at the power-house will be carried a distance of 3½ miles to Pelzer, where it will enter the mills and drive one 400-h.p. synchronous motor wound for high potential and several multiphase motors of varying capacities from 5 h.p. up to 110 h.p. The majority of these motors will be of the inverted type, suspended from the ceiling in the different rooms. They will receive the current at a low potential from step-down transformers, placed in the sub-station at the mills. The mills will also be lighted from the same circuit.

Presentations.—Last week a couple of presentations were made as testimonials of regard to Prof. W. Wilson, M.A., who has for five years and a half been in charge of the electrical engineering department of the Merchant Venturers' Technical College at Bristol. In the first place, the pupils of the boys' school of the college assembled in the great hall, when some handsome ornaments were presented to Prof. Wilson by those forms which had studied applied physics under him, and subsequently in the physical lecture theatre there was a meeting of the senior students of the college with the principal (Prof. Wertheimer) in the chair. The Chairman opened the proceedings by acknowledging, on behalf of the governors, his colleagues, and himself, the valuable services which Prof. Wilson had rendered to the electrical engineering department of the college, and expressed a hope that Prof. Wilson, in his new capacity as principal of the Salford municipal technical school, would meet with continued success and prosperity. Miss Fanny E. Jones, the senior lady student in the physics department, then presented to Prof. Wilson a large ornamental clock and figure, on behalf of the senior day students of the college, and Mr. James A. Seager, the senior student in the electrical engineering department, read an illuminated address which had been signed by the students. Prof. Wilson suitably replied.

A Graphic Description.—The following item of news comes from America. It is to be presumed that the town mentioned is Guthrie, in Oklahoma. Both town and State are still very new, but it is evident that in describing a lightning stroke, the local reporter is prepared "to see anyone else and go better." That numerous class of people who prefer artistic effect to absolute accuracy, ought to be satisfied at any rate. "The Baptist church at Guthrie, the steeple of which is 170ft. high, is being repaired, and two men were on a scaffolding at the summit of the steeple, engaged in painting it. Suddenly, a thunderstorm arose, and the sky was seamed with a series of vivid flashes of lightning. One stroke severed the ropes that supported the scaffold, which fell with a crash on the pavement below. The two men, however, saved themselves from falling by clinging to the top of the lightning-rod, but only to meet a more dreadful fate. A second stroke of lightning killed both the men and ignited their clothing, which burnt fiercely for 10 minutes or more, to the horror of the large crowd that was watching below. The stiffened and charred bodies remained clinging to the rod for three hours before the blackened corpses, seared beyond recognition, could be lowered to the ground." One can almost imagine the reporter standing at the door of the neighbouring saloon watching the event.

American Tramway Rules.—With a view to preventing the effects of electrolysis, the municipal authorities of Richmond, Virginia, have passed a city ordinance which is binding on the tramway companies. The principal points insisted on are: the rails should be electrically welded at the joints, or, if separated, they shall be bonded; for 10lb. to 60lb. rails one bond shall be used; for 60lb. to 90lb. they shall have two bonds; where joined the rails shall be drilled, the bond threaded and secured to the web with copper washers and an iron nut, the surface of the rail being first cleaned. The contact shall be made with bright surfaces, and shall have not less than 10 times the area of the bonding wire. The outside shall be thoroughly painted with insulating paint. Every third rail shall be cross-bonded. A continuous supplemental wire shall be laid in the centre of each track and connected to each rail every 300ft.; the size of this wire shall be equal in area to that of all the feeders for that section; in all cases the rails are to be connected to the negative 'bus bar. When the current is returned from the track to the power station there shall be provided and maintained a metallic circuit of old rails bonded together, or some similar metallic return of ample area; under no conditions shall the current be grounded at any point near gas or water mains. Whenever an ammeter indicates a current from the gas or water mains to the rails steps must be taken to stop it, a fine being imposed for non-compliance. If any damage is done to the water or gas mains, the company shall be held liable to the city.

Civil Engineers' Benevolent Fund.—The annual report and accounts of the Benevolent Fund of the Institution of Civil Engineers show that the fund, which has now been established nearly a third of a century, is distributing assistance to the extent of from £3,500 to £4,000 per annum. During the past year there has been a slight diminution in the number of applications for assistance, as well as a decrease in the amount of money granted, as compared with last year, the actual figures being 67 and £3,581. 6s. 8d., as compared with 74 and £4,096. 7s. 8d. respectively in 1894. It has been, however, again necessary to dispose of some of the reserve in order to meet the claims upon the fund. The income of the year has been from annual subscriptions, £1,696. 9s.; dividends on investments, £1,585. 10s. 2d.; donations not directed to be added to capital, £349. 2s. 6d.; and interest on deposit, £2. 10s. 11d.; or a total of £3,633. 12s. 7d. This, added to the proceeds of the sale of £250 3 per cent. stock taken from the rest account and producing £288. 10s., with the balance of £14. 9s. 7d. from last year, makes the total of £3,936. 12s. 2d. on the credit side of the account. On the other hand, the expenditure has been for grants, £3,581. 6s. 8d.; disbursements (for printing, stationery, postage, auditors' fees, and a small gratuity to the clerks), £115. 9s. 10d.; leaving unexpended £239. 15s. 8d., which completes the balance. The benefit derived from the distribution of so large a sum as £3,581 must be very great, and the committee and the institution may reasonably be congratulated on the amount. It is, however, impossible to continue it unless there is a strong subscription list, and the committee strongly urge the need for further subscriptions, since the ordinary income of the fund is insufficient to meet the calls upon

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it; and the committee consider that from an institution numbering upwards of 6,000, there should not be difficulty in obtaining annual subscriptions and donations to a larger extent than £2,045. 11s. 6d., the amount given last year.

The Metric System. — In the holiday season newspapers have space to spare, and the *Times* has taken advantage of this to devote about three columns and a half to reasons against adopting the metric system. None of these are new, and most are not particularly forcible. However, we are taken back to Sir John Herschell and the old complaint that you can only divide 10 once by 2, and the remarkable virtues of the number 12 are enforced just as if our weights and measures went all by dozens and our arithmetic by duodecimals. Moreover, the metric system will carry with it the centigrade thermometer scale. *Non sequitur*, but if it did, what is deliberately preferred by the chemists and physicists ought to be good enough for gardeners and meteorologists. The only safe refuge for people who are afraid of a minus sign is to measure in absolute temperature. Unfortunately, a great deal has happened since the time of Sir John Herschell, and, among other things, the fact that the most important nations in the world, except England and her Colonies and the United States, have adopted the metric system. If a better than the metric system had been started at the beginning, it would no doubt have prevailed. Only it was not. The most remarkable thing, however, is in a second article at its conclusion, which falls into the form of a conversation, and is as follows: "But what about the immense facilities which the method of decimal calculation gives us? You seem ready to sacrifice all these? Not in the least. It needs only a small alteration in our method of numbering to make calculation by groups of 12 exactly similar to calculation by groups of 10; yielding just the same facilities as those now supposed to belong only to decimals. This seems a surprising statement; but I leave you to think about it, and if you cannot make out how it may be I will explain presently." From a third article it appears that this means nothing less than the alteration of the base of the scale of notation from 10 to 12, which is indeed an appalling and revolutionary proposition.

Poplar Trees as Lightning Conductors.—The second and concluding article by Dr. Cl. Hess on the question of how far poplar trees, and in particular the Lombardy poplar, planted in the neighbourhood of buildings may be depended upon to act as lightning conductors, has appeared in the *Elektrotechnische Zeitschrift*. In England it has always been an article of popular faith that tall trees close to a house increased the danger of its being struck by lightning, and though the risk might be considered negligible, and as a matter of fact is neglected, no one would suggest that; trees acted as a protection. It will, therefore, be no surprise to find that Dr. Hess decidedly pronounces against the idea that Lombardy poplars planted round a house will in any way protect it from lightning. On the contrary, so far from poplars planted near buildings being as good as lightning conductors, Dr. Hess shows that by their position they may become more dangerous than useful, and he endeavours to determine the best and worst distances. From a number of cases cited it is demonstrated that by increasing the number of trees the protection is not increased, and that absolute protection is not obtained even by a circle of trees. What happens is that the lightning jumps from the trees to the house, and it is stated that the danger in the current jumping from the trees to the roof of a building is considerable when the distance between them is less than 6½ft. As a house (possibly containing metal troughing and pipes) may very well give a better conductor and a better earth than the trunk of a poplar, this is just what might be expected *à priori*, and there will be little disposition to dissent from the conclusions reached. Any other result would, in fact, involve as a consequence that to stand close to a tall tree was a safe and advisable thing to do in a thunderstorm. In the course of the second article, some diagrams are given of a method of protecting a house in the immediate proximity of trees by running a wire electrically connected to earth along all the ridges of the building that come near a tree. Now, such an arrangement as this seems eminently adapted to promote the tree being struck, and, though the wire might be quite capable of carrying off the discharge without damage when it reached it, there might very easily be a good deal more in the way of broken branches and split bark than would be desirable.

British Association.—The local committee are well in advance with their arrangements for the sixty-sixth meeting of the British Association, which takes place in Liverpool, on September 16, under the presidency of Sir Joseph Lister, M.D., F.R.C.S., president of the Royal Society. The honorary local secretaries (Messrs. W. A. Herdman, J. C. Thompson, and W. E. Willink) state that invitations have been sent to the most eminent men of science in America and on the Continent, and a number of these it is believed will accept the invitation. Excursions will be organised to places of special interest in the district around Liverpool, and longer trips are being arranged to the Isle of Man and to the English lakes at the conclusion of the meeting. The reception-room will be in St. George's Hall, which is in the centre of the town and close to the chief railway stations, and about half of the sections will meet in that building and the immediate neighbourhood; while the remaining sections will be placed in University College, which is within half a mile of the reception-room. The lecture theatres and laboratories of the college will be available for demonstrations and for experimental illustration, and a loan museum will be formed in connection with the biological department. The evening addresses will be delivered in the Philharmonic Hall. One of the conversaziones will be held in the Town Hall and the other in the Museum and Walker Art Galleries, where the autumn exhibition will at that time be on view. There are to be the full number of 10 sections, including physiology, started at Oxford and suspended last year, and botany, started at Ipswich last year. The presidents of sections nominated by the council are as follows: Section A, Mathematical and Physical Science—Prof. J. J. Thomson, M.A., D.Sc., F.R.S.; Section B, Chemistry—Mr. Ludwig Mond, Ph.D., F.R.S., V.P.C.S.; Section C, Geology—Mr. J. E. Marr, M.A., F.R.S., Sec.G.S.; Section D, Zoology—Prof. E. B. Poulton, M.A., F.R.S.; Section E, Geography—Major Leonard Darwin, Sec.R.G.S.; Section F, Economic Science and Statistics—the Right Hon. Leonard H. Courtney, M.P.; Section G, Mechanical Science—Sir C. Douglas Fox, M.I.C.E.; Section H, Anthropology—Mr. Arthur J. Evans, M.A., F.S.A.; Section I, Physiology—Mr. W. H. Gaskell, M.D., F.R.S.; Section K, Botany—Mr. D. H. Scott, M.A., Ph.D., F.R.S. The office of the local secretaries is 5, Fenwick-street, Liverpool, to which communications and enquiries may be addressed.

Mountain Telephone Lines.—A short description has been given by Mr. J. W. Dickerson in the New York *Electrical World* of the system owned by the Colorado Telephone Company, which furnishes communication between all important points in the heart of Colorado. The main trunk line lies north and south, and extends

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from Raton, in New Mexico, as far as Eaton, within 25 miles of the Wyoming border. Branches extend from the main trunk to all places of consequence as far west as Aspen. The company also owns a comparatively short connected system in New Mexico with Las Vegas as a centre. Isolated exchanges are maintained in several cities and towns, some of which may in time be connected with the long-distance system. The headquarters of the company are in Denver, and the telephone building in Lawrence-street is one of the best arranged structures of the kind to be found anywhere. Colorado is intersected by the Rocky Mountains, and consequently, of the 664 miles of pole line owned by the company, at least 300 miles have been built in mountainous districts, and in the extensions of the system in these localities the most interesting features of its construction are to be found. The building of these mountain lines has been expensive, as many difficulties have had to be surmounted, but the great outlay has, as a rule, been justified and has been appreciated by the public. The service is liberally patronised, so liberally indeed that the existing facilities are greatly overtaxed at some points, and plans for adding new circuits and providing additional improvements of various kinds are under consideration. In ordinary construction the poles are set 42 to the mile, but in many places the lines are full of sharp turns so that the number of poles per mile goes up to 75. When going through trees the timber is cleared for 200ft. on each side of the line, as the district is subject to severe storms, and the line would otherwise be liable to frequent interruption from tree falls. The construction gang therefore have to be woodmen as well as linesmen. In the rocky ground making the holes for the poles is often a serious matter. On the Leadville-Aspen line, which crosses the "Continental divide" at an elevation of 12,000ft. above the sea-level, aerial construction had to be abandoned at the summit in favour of a cable, as it was found that even No. 6 wire with poles every five yards would not stand when sleet accumulated on it. In spite of the southern latitude the climate in the Colorado mountains is exceedingly severe, and in the winter-time linesmen doing repairs have to travel on snowshoes.

Transformer Losses.—Writing on the subject of central-station working in the New York *Electrical World*, Mr. R. E. Richardson makes "A Few Suggestions to Station Owners as to the Selection of Transformers." The suggestions amount to this—that wherever possible large transformers should be used instead of small ones, and that if an alternating-current plant is not working as economically as could be desired one of the first things to be investigated is whether the loss is not due to using an unnecessary quantity of small transformers. The central-station engineer has realised for some time that if he wished to reduce his coal bill and working expenses and increase the income from his plant he could do so by simply replacing small transformers with larger units and bunching his secondaries. It is evident, however, that in the case of factory lighting, etc., or lighting in a thickly-populated town, large units in transformers can be used to a much better advantage than in the case of widely-distributed residence lighting, as in that case the cost of copper or loss incurred in the secondaries in attempting to use large central units would ordinarily be more than the extra loss due to the use of a number of small transformers. Mr. Richardson, however, says the fact is not so well appreciated in America as it should be. A short time ago his attention was called to two plants, both of some 3,000-light transformer capacity—the largest transformer in use on one plant was a 30-lighter, and the bulk of the units were 5 and 10 lighters, though the local conditions were favourable to large units. Taking the loss in leakage and working it back to the coal pile, and then putting larger units in place of the existing transformers, the saving in coal alone by the change would, in a little over a year, pay for the entire new equipment of transformers, assuming that the old ones were thrown on the scrap heap. In the second case the owner was about to get some new station machinery, "as his present plant was loaded to its limit." Upon investigation, it was found that by putting in new transformers, instead of a new engine and dynamo, he would reduce his loss due to leakage to such an extent that not only would his present station apparatus not be overloaded, but he could even connect more lamps to his present lighting plant. The same conditions can be found to a greater or less degree throughout the United States. It is further pointed out that even where water power is available or coal is cheap, "as the efficiency and regulation of a transformer are interdependent, and the leakage current determines the efficiency, the station operator should most carefully take into consideration both sides of the question, and try to select those transformers which will give to him the minimum leakage current without sacrificing his regulation to such an extent as to give poor service to his customers or unduly shorten the life of his lamps." Too often failures have been attributed to the system adopted, when the fault should have been laid directly at the door of the designer of the plant. Mr. Richardson compares a central station with an alternating system to a business house with a number of employés, each one an expense to feed and maintain. "A central station is a business house, not selling and delivering boots and shoes, dry goods and groceries, but electricity, and that it must be run on the same business principles and with the same business precaution that is taken in other lines of business." Reasons such as are indicated above may account for the smaller favour with which alternating current systems are regarded in America.

The Telephone Service.—The transfer of the trunk telephone lines to the Post Office on Saturday last has been the occasion of a special article in the *Times*, which considers it to be a first step in the nationalisation of the telephones. When the transfer has been fully completed according to the scheme of joint working to be undertaken by the Post Office and the National Telephone Company, "the exchanges of the company are to be connected with the nearest post offices, and at such post offices call offices are to be established. Thus, any person wishing to speak to a subscriber to any exchange may do so by calling at the principal post office of the town and asking to be put into communication with his correspondent. More than this, any person in, say, London wishing to speak to someone on, say, the Brighton exchange may call at the proper post office in London and be 'put through' to his friend at Brighton. Hitherto, not only communications between persons in the same town, but between one town and another have been almost exclusively confined to subscribers to telephone exchanges. In future, such conversations may largely take place between persons who use the telephone only for special purposes, and not habitually. Of course, the extent to which such casual conversations are held will depend upon the charges made for them. In most cases, both the Post Office and the company will be concerned in the transmission of the message. The Post Office charge for the use of its trunk wires must obviously be fixed, and will compare favourably with the charges hitherto made by the company, but the company may or may not think it necessary to make a charge for the terminal service—which seems, indeed, to be as much in

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the interests of the company's subscriber as in that of the caller." It is further added that a subscriber to an exchange may, when he wishes to send a written telegram, speak his message to the Post Office, and ask that it may be despatched over the telegraph wires in the ordinary way. Or he may ask the Post Office to send him a messenger and give him a letter or parcel to be carried express. "Thus the facilities now offered by the district messenger system will be at the disposal of every subscriber to a telephone exchange without the burden of an extra subscription and the inconvenience of a separate apparatus. Instead of summoning a boy from the District Messenger Company by turning the handle of that company's special call-box he will speak to the Post Office over his telephone, and thus at once secure a Post Office boy. And it is to be borne in mind that the charges of the Post Office for express letters are very low. It is a subsidiary advantage of the connection of exchange subscribers with the Post Office that the express messenger service can thus be carried on without the erection of an additional network of overhead wires. Again, a telephone subscriber wishing to catch a mail at the last moment may telephone a letter to be despatched by the ordinary post. And in the opposite direction arrangements may be made for the telephonic delivery of telegrams into a subscriber's office, the delay of delivery by messenger being thus avoided." After a summary of the circumstances under which the National Telephone Company acquired a practical monopoly of the telephone service in this country, the article concludes: "The Post Office has, in fact, as to the trunk-wire telephone business of the country, bought up for a large sum, the particulars of which, we believe, have not yet transpired, the competitor whom it launched in business 16 years ago. It remains to be seen how the public will be served under the new working agreement, and whether the residue of this same competitor's business will have to be acquired for a yet higher price, or whether the license, which still holds good for some 16 years, may be allowed to run out without injury to the development of that wonderful means of communication which is supplied by the telephone."

American Safety Rules.—The conference called by the Committee on Standard Rules of the National Electric Light Association has taken place at the headquarters of the American Society of Mechanical Engineers, New York. Mr. William J. Hammer presided, and stated that the object of the meeting was to harmonise as far as possible the various interests, and, if possible, to produce a standard set of rules for electrical construction which would be recognised and accepted by all who were engaged in such work. After some general discussion the conference took up the subject of rules on the basis of the six different codes now in use in the United States—namely, those of the Association, National Board of Fire Underwriters, Associated Factory Mutual Insurance, English Board of Trade and Phœnix Rules (new), German Code (new), and the Edison Illuminating Company. One point brought out in the discussion was that the rules of the N. B. F. U. were primarily composed with reference to the fire risk involved, while those of the N. E. L. A. had in view good construction. While the two objects are similar, they are not always the same. After discussion on the means of enforcing the rules when they were adopted, there being no central authority in America like the English Board of Trade. Mr. A. E. Kennelly read a paper on the safe carrying capacity of wires. The table of capacity recommended by the English Board of Trade and recommended by the N. E. L. A. allowed a rise in temperature of 10deg. to 12deg. C. The table of capacity of wires in use by the N. B. F. U. allowed a rise in temperature of from 25deg. to 50deg. F., and he thought this was too near the safe limit. Mr. Merrill said many contractors had complained that that limit was much too low, and Mr. Jones said that the trouble really was to make people stick to the limit originally intended for the wires. In case of an office building, for example, an outlet that was originally intended for five lights would often have extra lights or fan motors plugged in by the building electrician without consulting anybody, with the result that many circuits were loaded up to double their original capacity. Inspectors could not be expected to see all these things, and for that reason the limit of carrying capacity of wires should be low. The matter was referred to a committee. The question as to whether the dynamo frame should be insulated or grounded provoked a lively discussion. Mr. Scott thought that in alternating plants insulating the frame was useless, and that the static charge might be a source of danger to the attendant from touching the frame, whereas a grounded frame would be a factor of safety; also that dynamos carefully insulated at the base were connected to the engine by wire-woven belts. Captain Brophy agreed with Mr. Scott. Prof. Crocker said that the static charge could easily be taken care of by grounding through a very high resistance or a wet string or a vacuum tube which would take care of the static charge, but leave the dynamo insulated. The attendant should always be protected by an insulated flooring or platform, so that he could not possibly be grounded while handling the machine. Next came the question as to what was high and what low potential. Prof. Crocker said that, as in some cases, 200-volt lamps were being used, and asked whether under the rules a three wire system carrying 400 volts between outside wires would be excluded and treated as a high-potential system. He thought the limit as to low-potential circuits could be just as well raised to 425 volts. Captain Brophy said the Western Union and several other companies used high voltage, and he found it necessary to distinguish between them and companies using heavy currents. On the question of substituting plain iron pipe for the iron-armoured conduit, everyone present favoured the use of plain iron, if they could be convinced that burrs and fins in the pipe would not strip the insulation. As to cut-outs, Mr. M'Devitt said that fusible devices were all wrong, and that fuses are not reliable by 100 or 150 per cent., while Captain Brophy thought the ordinary run of fuse blocks a delusion and a snare. Mr. Greene, however, said that the fuse had been unjustly condemned because the time element had not been considered; supposing a fuse would not go for five or ten minutes, the wire would not get dangerously hot in that time. Mr. M'Devitt remarked that the insulation might become charred. Mr. Jones raised the question whether resonance affected fuses; but Mr. Kennelly said that resonance never gave any trouble. The questions of switches and the advisability of doing away with ceiling rosettes were referred to committee. As to grounding the secondary coils of transformers, the English and Phœnix rules on this subject were read and discussed at length, and the whole subject was finally referred to a committee. On the subject of car wiring, Mr. Ford thought that under proper restriction lights and motors might be taken from trolley lines in places where no other electric power was available, but Mr. Merrill said that with the restrictions that would be demanded it would be better to instal an isolated plant, and under all the circumstances that it would be better to prohibit such work altogether. It was further decided to postpone the adoption of by-laws. It will thus be seen that nearly everything was referred and nothing was settled. The conference will meet again in June.

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BOILERS AT ELECTRIC LIGHT STATIONS.*

There is a cause for everything, if not a reason. It is not always easy to see what the cause may be, or to be satisfied with the reason. But the fact remains. In electricity manufactories or electric light stations, whichever they may be called, it is noteworthy that steam is generated on a system different from that which has for half a century at least satisfied millowners, and indeed manufacturers of almost all known commodities. For ordinary manufacturing purposes the Lancashire or the Cornish boiler is used almost to the exclusion of all other types. The former is no doubt an excellent example of the survival of the fittest, and its all but universal adoption is the result of a careful calculation based on commercial principles. From the first, however, the Lancashire boiler has been almost absent from electric light installations. It is only recently that it begins to be used in a tentative fashion by electric light engineers. In not only the United States, but this country as well, we find that boilers of the water-tube or locomotive type are nearly always employed to drive electrical machinery. There must be some reason for this. We do not think that it has ever been stated; but it does not seem to be far to seek, and when found it is instructive.

When electric light stations were first designed in this country the designers were in almost every case electricians, not mechanical engineers; or at least not mechanical engineers possessing any considerable commercial knowledge of the working of steam machinery. These gentlemen knew from books that high-pressure steam was more economical than low-pressure steam, in the sense, at least, that a smaller weight of the former than of the latter would give a horse-power, so it was determined that high-pressure steam must be used. But the Lancashire boiler was not deemed suitable for pressures over 100lb., so recourse was had to water-tube boilers; and to locomotive type boilers because it was a familiar fact that on our railways pressures of 150lb. and more were regularly carried. It is no disparagement of the water-tube boiler to say that the results of its adoption have not been uniformly satisfactory. It is, for one thing, peculiarly exigent in its demands for good water, and in the second it is very expensive to keep clean, and if not kept clean the tubes split and leak. The locomotive boiler, again, is a very admirable steam generator, but it, too, has its peculiarities. It is the full consciousness of these things that has induced millowners to resist all temptation to use any other than the double-flued or Lancashire boiler, which has been recently so proportioned that it will carry any pressure asked for. Indeed, it should be almost self-evident that if a marine boiler 15ft. or 16ft. in diameter can carry a pressure of 160lb., there ought to be no difficulty in making a Lancashire boiler of half the diameter equally strong. The mistake committed by the electrical engineers has been in assuming that the boiler which made steam most readily, and was most economical in the consumption of coal, must be the best. It is just the species of error into which the non-commercial engineer is likely to fall. The truth is that coal represents but one item in the cost of making steam, and it is not invariably the most important item. The price to be paid for water is not infrequently very large; and even high-priced water may not suit either water-tube or locomotive boilers. Then there is the question of wear and tear, the quality of the steam produced, and many other matters which must all be considered before it is possible to say what is the best type of boiler to put down; and all this, be it noticed, has nothing whatever to do with the qualities of the boiler regarded from the theoretical point of view.

To make our meaning quite clear, let us suppose that a sum of £500 is available for the purchase and erection of a boiler. We may obtain with this a Lancashire boiler which will work well and give satisfaction for 10 years, with very moderate repairs, and be nearly as good and serviceable at the end of that time as it was at the beginning; or we may get a locomotive boiler which will need heavy repairs before half that period has elapsed, and will be good for very little at the end of the term. Or a water-tube boiler, which will last for half a century, simply because it has new tubes put in, a few at a time, all the year round, every year of its life. All three may be of equal evaporative efficiency, but even if they were not, the millowner would keep to the Lancashire boiler, not only because it would, in the long run, be much the cheaper of the three, but because it would always be ready when wanted. It would seldom, if ever, be laid off for repairs. No doubt it may be urged, and urged with truth, that both the water-tube and locomotive boilers are excellent steam generators. This does not affect the question in any way. All the experience available goes to show that over a series of years the Lancashire boiler will be found less costly in up-keep, and more trustworthy than any other type of land boiler in the market; and that this truth is gradually coming home to electrical engineers is demonstrated by the circumstance that recourse is now being had to the Lancashire boiler in very important installations, to an extent, indeed, not dreamed of a few years ago—that at St. Pancras, for example, which we illustrate this week. It must be understood that in writing as we do, we are simply bringing before our readers certain considerations often overlooked, and endeavouring to find a cause, if not a reason, for the remarkable departure from normal practice which marked the advent of the electric light in this country. It can scarcely fail to strike any thoughtful man as remarkable that types of boilers scarcely known in Great Britain should have been used to the exclusion of all other types for supplying steam to electric engines. Outside of railway shops no locomotive type boilers could be found driving stationary engines of more than a comparatively few horse-power. In factories they are practically unknown. The water-tube boiler fought for its life in Great Britain. All over the kingdom, in spinning and weaving mills, pumping stations, factories of all kinds, many rolling mills of the largest size, nothing was used but the Lancashire boiler. But with the new light all this was changed, and we had not only the electrical experiment, but the steam generating experiment as well, and it is not remarkable that the results were not always quite satisfactory.

It would not be fair, however, to attribute the adoption of the locomotive type or the water-tube boiler either to caprice or theoretical knowledge alone. No doubt installations were often constructed under circumstances that rendered it next to impossible to use anything but the water-tube boiler. There are places in the Andes where no part of a steam-engine or boiler must weigh more than 200lb. Everything has to be carried on mule back. There are places in great cities into which it is equally impossible to convey any large structure. For such places the sectional boiler is simply invaluable. But this scarcely suffices to explain the favour which the locomotive type of boiler enjoys. It is not because only such a boiler can be forced, and other reasons must be found for its adoption That it requires no brickwork and is an excellent steam maker are no doubt points very much indeed in its favour; but, when all this has been said and admitted, we have still to face the fact that for places where large demands are made for steam, day after day, nothing is so popular as the Lancashire boiler, or its modifications.

Those who can read the signs of the times know that the production of electricity on a small scale in numerous establishments will have to give way to its manufacture wholesale, on a great scale. That which has become possible at Beckton with gas may become equally possible with electricity. The question will then force itself on engineers, What is the best method of manufacturing steam? It is not wise to prophesy until after the event. Yet we are rash enough to say that probably the Lancashire boiler will be used in conjunction with mechanical stokers, the smallest possible amount of manual labour being employed. In settling this question it must not be forgotten that the demand for power becomes more and more uniform the larger the installation, and, consequently, the wider the district served. "The peak" does not occur, for instance, in all existing metropolitan installations at the same hour. This consideration will have an important influence on those who have to select the type of boiler to be used. Furthermore, the heat storage system introduced by Mr. Druitt Halpin may modify conditions of service very considerably. In saying this we do not wish, as we have said before, to be understood as finding fault with any particular type of boiler. Our object is to record what may be termed the drift of public opinion. It does not follow that we regard the water-tube boiler as inferior to the Lancashire if we state as a fact

* From the *Engineer*.

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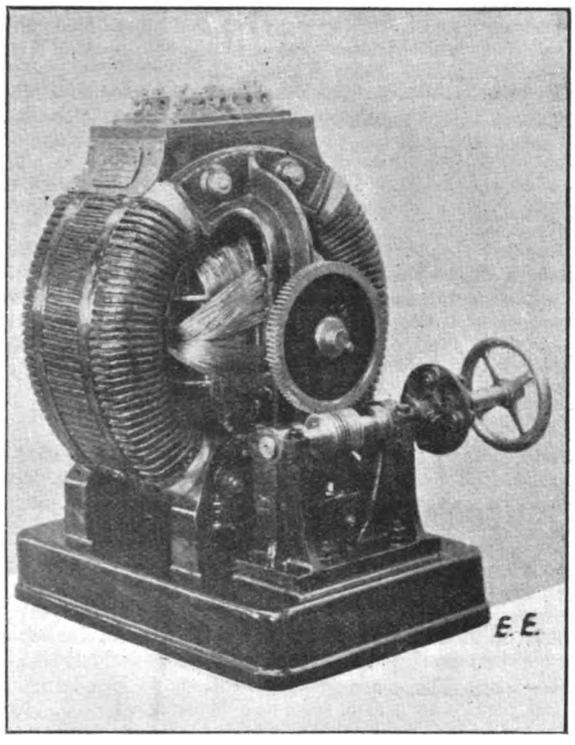
that millowners prefer the latter, and that electrical engineers in taking to the former have departed from precedent. The doubt and hesitation which exist are fairly well exemplified on a small scale at Islington, where Mr. Gay has put down both Lancashire and water-tube boilers almost side by side. It must, too, be borne in mind that nearly all the electric light stations in this country are comparatively young, and few opportunities have yet been afforded for testing the actual life of a boiler. Our purpose will have been served if we have succeeded in directing the attention of our readers interested in the manufacture of electricity to the fact that a considerable departure from normal manufacturing practice has marked the progress of the electrical engineer, and that many more things than the production of steam have to be thought of when ordering a boiler.

THE REGULATION OF PRESSURE AND THE REDUCTION OF LIGHT-LOAD LOSSES IN ALTERNATING-CURRENT SYSTEMS OF ELECTRIC SUPPLY.*

BY E. W. COWAN AND ALFRED STILL.

(Concluded from page 355.)

On the table we have one of the Manchester Edison-Swan regulators at work. The Manchester supply being a continuous



The "Manchester Edison-Swan" Regulating Transformer.

current, a motor alternator first converts it into an alternating current of about 20 complete periods per second. The alternating current supplies an incandescent lamp, and the regulator is so connected that the pressure at the lamp terminals can be raised or lowered by hand adjustment of the lever on the side of the case.

Compensators.—With regard to the means of indicating the feeding point volts at the station end, there are several methods by which this can be done. Pilot wires brought back from the feeding points to the voltmeters naturally suggest themselves in the first place, but there are objections to their use, of which the principal one, perhaps, is their excessive cost, especially when they are used in connection with long feeders. A very simple method of indicating what is the required pressure at the station end of the feeders in order that the supply at the far end may be independent of variation in load, consists in marking on the feeder ammeters a second scale of numbers—let us say in red figures—these numbers to indicate the required value of the station volts for any position of the ammeter needle. A step in advance of this, is a method which is more generally used in America than in this country. It consists in connecting the voltmeter in series with the secondaries of two transformers—a shunt transformer, T (Fig. A, Diagram 5), with its primary across the mains, and a series transformer, T 2, of which the primary is traversed by the main current. The secondary of this transformer being closed through an adjustable resistance, R, it will be readily seen that by suitably varying this resistance to suit the length and size of the feeder, the potential difference between the terminals, *t t*, may be adjusted to any particular fraction of the volts lost in the feeder. It follows that by setting this potential difference against the potential difference at the secondary terminals of the shunt transformer, the readings on the voltmeter will be an indication of the actual pressure at the feeding point. In Fig. B on the same diagram is shown the way in which this method of "compounding" the feeder voltmeter is illustrated in Dr. J. A. Fleming's book on "Transformers." In the text we read that "the E.M.F.'s of the two transformers are opposed to one another"; but this will not be the case unless the secondary of the series transformer is closed through a resistance, as in Fig. A. The secondary volts of the shunt transformer being in opposite phase to the primary volts, and the induced volts in the series transformer being approximately quarter period behind this main current, the two E.M.F.'s cannot be set against one another, and their sum must necessarily be greater than the value of any one of them.

Drop in Distributors, etc.—We have so far dealt only with the loss of pressure in the feeders and methods of keeping the volts constant at the feeding points. Beyond this the system must be self-regulating—that is to say, the loss in pressure between no load and full load must not exceed a certain definite amount. The amount of permissible variation at the consumer's terminals as fixed by the Board of Trade is 4 per cent. If, therefore, we proportion the distributors to give a maximum drop not exceeding 2 per cent., this leaves another 2 per cent. for permissible drop in transformers.

And here it may be as well to point out the disadvantage of specifying for transformers having a very small drop between

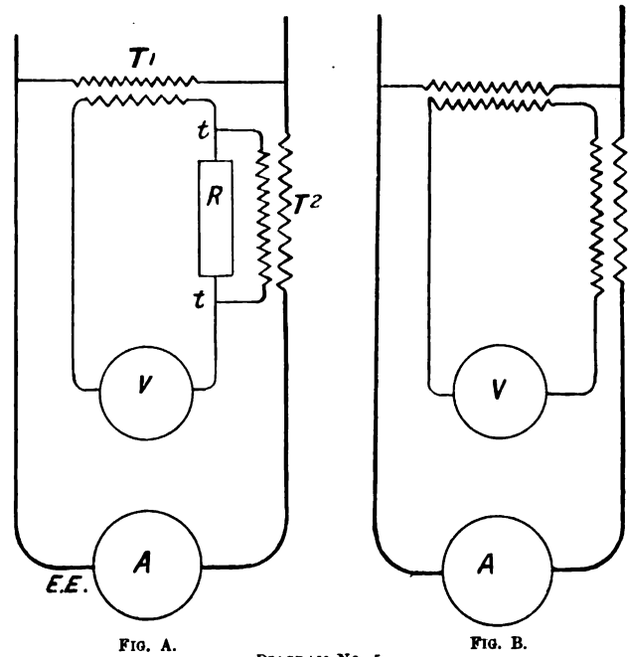


FIG. A. FIG. B.

DIAGRAM NO. 5.

no load and full load, without considering the effect of the drop upon the first cost and efficiency at light loads. It should always be borne in mind that for the same cost of material a transformer may be made to give either a small drop with a comparatively large iron loss or a fairly considerable drop with greatly reduced open-circuit losses. As an illustration in actual practice which bears out this statement, a few months ago we tested a transformer for which the makers claimed an unusually small loss at light loads. The tests proved that the claim was undoubtedly well justified, but at what cost? The drop on volts on secondary terminals between no load and full load was no less than 5 per cent. On the other hand, a transformer of the same output by another maker had an open-circuit loss nearly one and a half times as great, and this, although the weight of the transformer, and therefore the amount of material in it, was greater than the first one; but this greater iron loss was necessary in order to bring the drop within reasonable limits, the maximum variation being just within 2 per cent. In very small transformers it is difficult to keep the drop much below 2½ per cent.; a better regulation than this is rarely found in practice, notwithstanding specifications and makers' published figures. With regard to the drop of pressure in the house wiring, we believe there is very little that is new to be said on

* Paper read before the Northern Society of Electrical Engineers, March 23, 1896.

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the subject. It should, however, be borne in mind in calculating sizes of wires that their effective resistance to alternating currents is always a little greater than when they are traversed by a continuous current. Mr. E. Hospitalier has worked out a very convenient table which will be found reproduced in the *Electrician* of January 12, 1894, and from which the increased resistance of wires to alternating currents for various diameters and frequencies may be easily obtained. It is perhaps needless to remark that this increased resistance is practically negligible except for wires, say, over ½in. in diameter, and comparatively high frequencies.

Before leaving this first section of the paper, it should perhaps be mentioned that a small regulating transformer connected in series with the low-tension wires entering the houses may be used for keeping the pressure constant within a fraction of a volt, notwithstanding variations in the supply at the consumer's terminals. One of these house regulators is on the able.

Reduction of Light-Load Losses.

There are few subjects of greater interest to the electrical engineer in charge of an electricity supply station than the question of light-load economy. The maintenance of a continuous supply cannot be avoided, but the cost of generation during the hours of light load is enormous. The waste—and no other word adequately expresses the loss which takes place—is not only in fuel, but in wages and capital. There is no occasion to define the lightness of the load during the small hours of the morning and the long hours of daylight. In the majority of electric light stations in this country the feeder ammeter needles rest persistently at zero. It is to such stations that our remarks will apply. An examination of the question shows us that there are perhaps four ways of meeting the difficulty: (1) installing accumulators which are charged during the hours of heavy load and employed during the hours of light load in driving a motor alternator of a similar kind to the one on the table, but, of course, multipolar; (2) by running a small and, therefore, more economical light-load plant; (3) by a gas-engine and gas-generator plant; (4) by adapting one of the smaller units in the station to work at a relatively high economy when lightly loaded. Below we deal briefly with these four methods.

Installing Accumulators.—Mr. J. C. Howell, supported by Mr. Crompton, endeavoured some time ago to persuade the members of this society that accumulators offered a means of saving many tons of coal per diem, even if they were only used as resistances for shunting the balance of current required to raise to full load the output of a steam dynamo. This startling assertion was accepted in many quarters, but we are unable to allow that accumulators can possess such a virtue. The question of their adaptability to alternate-current stations in conjunction with a motor alternator to effect economy becomes a difficult one to decide. The Bolton Corporation are putting this plan to a practical test, and we shall look forward to hearing at a later date some account of their experiment. It is a question of interest on capital outlay, depreciation and maintenance, on the one hand, against saving in fuel and wages, and also the undoubted advantage of being able at times to shut down the steam plant entirely, on the other.

Separate Light-Load Plant.—This is the plan which has found most favour up to the present time. One objection is its first cost, and another the frequent necessity for changing over from one plant to another, which, as it involves paralleling, needs the presence of a skilled attendant. This is felt most in the early morning in winter time, when the load is relatively heavy for an hour or two and a small plant cannot meet the demand.

Gas-Engine and Gas-Generating Plant.—At first sight, a gas-engine appears particularly fitted for this purpose, as it is theoretically an engine with a high efficiency at light load, on account of the gas consumed being proportional to the indicated horse-power. But there is another factor which influences the gas consumption—viz., the friction of the engine. In order to adapt a gas-engine to driving an alternator it must have two or more cylinders and a heavy flywheel, the consequence being that the standing friction losses are largely increased, thus seriously affecting the economy at light loads. The first cost of such a plant is, of course, much higher than that of a steam-engine of similar power.

Adapting One of the Smaller Units in the Station to Work at Relatively High Economy when Lightly Loaded.—We are fully aware that in recommending this plan as being the most effective and economical, we are laying ourselves open to considerable criticism, especially as some of the suggestions we shall make are in the direction of rather bold departures from present practice. But it must be remembered that in dealing with the difficulties of a low "load-factor" we must expect to be obliged to surrender some of our prejudices. The difficulties are peculiar, and may have to be met in a peculiar manner. It is impossible to deal with this subject without saying something about the many arrangements which tend towards economy at light load in the generation and transmission of steam. Time will not admit of the discussion of the different types of boilers. It is, of course, unwise to instal a small boiler for light load, and we do not suppose that anyone would think of doing so, but it does not seem to be generally so well known that a Lancashire boiler at any rate works at a much higher economy at quarter load than at full load if it is well lagged and carefully stoked. A boiler cannot have too much heating surface, though it can have too much grate area. With careful stoking, a consumption of 5lb. of fuel per square foot of grate area per hour in a Lancashire boiler will give a splendid evaporative performance of over 12lb. of steam from and at 212deg. F. per pound of coal, or 10 per cent. better than with a normal consumption of 20lb. of coal per square foot of grate per hour.

Economiser.—It might be thought that an economiser would not effect much saving at light loads, on account of the lower temperature of gases; but we have obtained an augmentation of temperature of the feed of 138deg. F. with a 96-tube Green economiser, when working a Lancashire boiler 30ft. by 7ft. at quarter load, and burning 5lb. of fuel per square foot of grate per hour. Prof. Kennedy has obtained an evaporation of 12·4lb. of water per pound of fuel with economiser, and 11·7 without, when burning only 6lb. of fuel per square foot of grate per hour.

Boiler Feed.—The wastefulness of steam feed pumps is well known, and in many stations electrically-driven pumps are now being fitted. Where the feed water is heated above 150deg. F. a feed pump of some sort becomes necessary, but in other cases injectors offer a means of feeding the boiler which is simple, inexpensive, and, we venture to say, economical. The three objections generally made against the use of injectors are unreliability, small range of regulation, and, lastly, that they are uneconomical. As to the first objection of unreliability, this is not borne out in practice so far as our experience goes, but a steam-pump as a stand-by should undoubtedly be erected. The second objection of the small range is easily got over by fixing three or four different sized injectors delivering in parallel into a common or "omnibus" delivery pipe. They work perfectly well in parallel, and in this way any required rate of feed can be obtained. The third objection of their being uneconomical is not, we think, a true one. Both in theory and in practice, as far as we have been able to ascertain, they are more economical than steam-pumps. As a pump pure and simple the injector is of course very inefficient, but energy cannot be extinguished, and it therefore follows that all the units of heat in the steam supplied to the injector are returned to the boiler, with the exception of the equivalent of the work done (the product of the volume of water injected and the back pressure), and a small loss due to radiation. It must, of course, be remembered that though all the heat is returned to the boiler, it is returned at a lower temperature—in fact, the live steam is used to heat the feed water from, say, 60deg. F. to 150deg. F., and this process violates one of the first conditions of economy. But compare it with an ordinary steam-pump; about 50 per cent. of the total heat in the steam supplied to the pump is rejected in the exhaust, to which must be added large losses due to radiation, and the more obscure losses due to reciprocation. It is difficult to compare the relative efficiencies of the one method which raises the temperature of the water from 60deg. F. to 150deg. F. by live steam, and from 150deg. to 320deg. in the boiler; and the method in which the temperature of the feed water is raised from 60deg. to 320deg. in the boiler; but common sense seems to point to there not being much difference between the two. The use of economiser or feed-water heater will of course somewhat alter matters, and each case should be considered on its own merits. Our firm conclusion is that an injector is the best light-load pump.

Steam-Pipes.—There are grave objections to supplying the light-load plant with steam from the main steam-pipe. This plant should be erected as close as possible to the boilers and supplied by a short auxiliary pipe of small diameter. It has been estimated that the radiated heat from every square foot of lagged steam-pipe costs 300lb. of coal per annum, and Prof. Kennedy has found that the amount of condensed steam from pipes, drains, etc., amounted in one station to from 8 to 9 per cent., and in another from 5 to 6 per cent. of the total weight of feed water.

Auxiliaries.—The economiser scrapers, centrifugal pump, and exciting dynamo must be driven during the hours of light load, and it is evident that if these are driven separately by auxiliary engines the result will be a serious waste of steam. We prefer to arrange for their being driven by the main day-load engine, using either belt, rope, or electrical transmission. As this engine is running in any case, its standing losses are not chargeable against the small extra power required, which can therefore be obtained at the very small expenditure of steam of about 12lb. per horse-power.

Condensers.—We unhesitatingly recommend the ejector condenser as being the most economical light-load type. No air-pump is needed, and thereby a substantial standing loss avoided. It is an absolutely reliable, cheap, and efficient piece of apparatus. The type with a means of regulating the adjustment of the nozzles is perhaps best suited to a variable load. The subject of the saving effected at light load by the removal of the standing loss of atmospheric back pressure by condensing

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the exhaust steam has been so ably and fully dealt with by Mr. Willans that we do not propose to add any remarks of our own, excepting to say that it is by far the most important of the means we are bringing before you for the reduction of light-load losses. We show on Diagram No. 6 the saving of steam effected during the daytime at Altrincham by the use of an ejector condenser. The diagram shows the indicated horse-power below and the indicated horse-power above the atmospheric line on the morning of December 20, 1895. The indicated horse-power below the atmospheric line amounted to about 46 per cent. of the whole, or a saving of steam consumption of about 50 per cent., against which must be set the horse-power required for centrifugal pump, about 1 per cent. of the total horse-power of the engine.

Engine.—The discussion of the engine brings us back to our recommendation that one of the smaller units should be adapted to run economically at light load. A steam-engine runs very wastefully under these conditions, partly on account of its standing losses being practically constant at all loads, and therefore bearing a larger proportion to the power developed at light load than at full load, and partly on account of the steam distribution between the high-pressure and low-pressure cylinders being unequal at light loads. The latter point should be dealt with by designing the engine with an automatic cut-off governor which acts on both the high-pressure and low-pressure valves. In this way a fairly equal range of temperature in the two cylinders can be maintained at all loads. The cylinders should also be steam jacketed on account of the range of expansion being relatively great at light loads. Of the standing losses, the back pressure of the exhaust has already been dealt with, and the loss due to radiation can only be met by careful lagging of the cylinders and their covers. Lastly, there are the important losses due to engine friction and vibration. The only way of reducing these is by lowering the engine speed. These losses are so much per revolution, and if we lower the speed we reduce them in like proportion. We recommend that the speed should be reduced by about one-third, and that the governor should be so designed as to allow of an adjustment of its springs being made by hand,

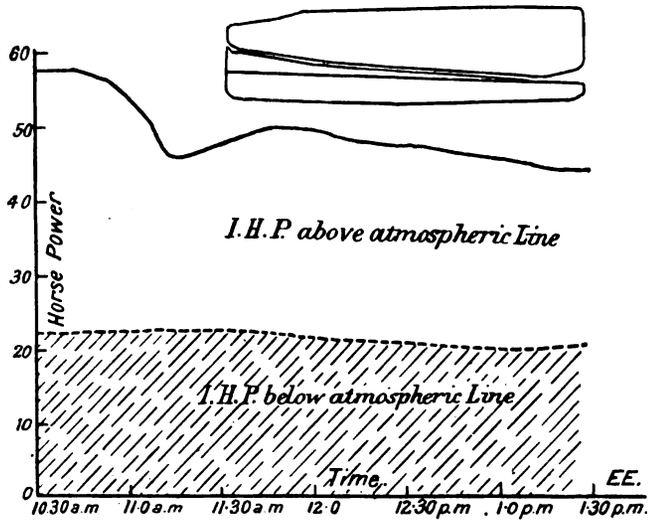

DIAGRAM NO. 6.

in order that the engine may be under its control at this reduced speed. As far as the engine is concerned there can be no doubt of the advantage of this plan; its effect on the electrical plant we deal with below.

Alternator.—The type of alternator which gives the highest efficiency at light load is undoubtedly the one having no iron core in its armature. But the reliability and mechanical strength of the iron-cored armature has so much to recommend it that it has found great favour, and we think rightly so, with central-station engineers. Probably the protection which the self-induction of the machine affords to the whole system in absolutely limiting the maximum current which it is possible to obtain from such an alternator, to only a harmless amount above the normal, has also done its part in placing this type in the position which it occupies at the present time. Engineers will readily sacrifice some efficiency and self-regulation to obtain such a "factor of safety" as the iron-cored alternator possesses. It must be remembered, however, that the eddy-current losses in an iron-cored armature are less at full load than on open circuit, a fact which was first, we believe, observed by Dr. John Hopkinson. We have recently made some experiments in connection with another matter in which this effect was very clearly marked. Apart from the windage and bearing friction, the hysteresis and eddy-current losses in an iron-cored armature when lightly loaded may be considerable. On account of the peculiar raking of the magnetic lines the iron losses in an armature for any particular values of the induction and frequency are greater than they would be if the same volume of iron were simply submitted to reversals of magnetism as in a transformer. The core losses in an alternator will increase approximately as the square of the induction; if, therefore, we could reduce the induction in the armature, a great saving of the all-day losses would be effected. For instance, suppose the armature to consist (as it often does) of two separate windings connected in parallel; by switching these in series during the hours of light load the induction in the core would be halved, and the iron losses consequently reduced to one-quarter of their former value, the losses in the exciting circuit being also reduced in the same proportion. Such an arrangement could not be worked without causing fluctuations in the light, but a little consideration will show that the same saving may be effected by the use of a step-up transformer. The alternator is excited to give, say, half its normal voltage, and its armature is connected in series with a transformer, wound to add the remaining half of the required volts. The loss in such a transformer will be very small compared with the saving in the alternator. All that now remains to be done is to make this transformer a regulating one, which will enable the volts added to be varied without any sudden fluctuations. The change of the alternator from a small-output machine to one capable of dealing with the full load it was designed for can

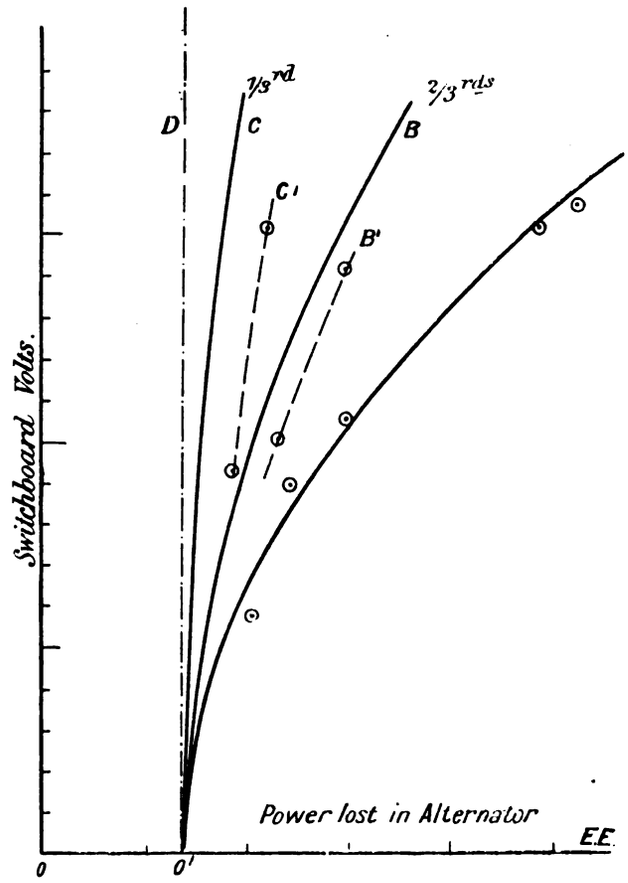

DIAGRAM NO. 7.

also be made without any variation in the light by simultaneously reducing the volts added by the step-up transformer and increasing the excitation of the alternator, as well as bringing up its speed, if this has been reduced as recommended when dealing with the question of engine efficiency. The capital outlay on such an apparatus would not in any case amount to much, but where regulating transformers are used for equalising the pressure at the various feeding points, as recommended in the first part of the paper, they can be without any difficulty adapted to do duty both as regulators of pressure and step-up transformers. The secondary must be wound with several separate windings, which, by means of a special switch, can be connected either in series or in parallel. By means of a simple interlocking device this switch may be so arranged that it can only be thrown over at a time when the transformer is in the position of no effect.

In Diagram No. 7 are plotted the results of some experiments which we have made on an iron-cored alternator in order to prove what has just been said with regard to the saving of alternator losses. The alternator was driven at constant speed on open circuit by means of a small continuous-current motor, and readings were taken of the power supplied to the motor for various inductions in the armature. In the diagram the vertical distances are proportional to the volts as read on an electrostatic voltmeter, and the horizontal distances are proportional to the power supplied to the motor, a correction being applied for the losses in the motor itself. The distance, O O_1, represents the losses in windage and bearing friction; it is the power required to drive the alternator with

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the field magnets unexcited. The curve O_1 A is a parabola, the distance of any point on the curve from the vertical line, O_1D, being proportional to the square of its height above the horizontal datum line. The points enclosed by the small circles are the results of the experiments, and by their agreement with the curve O_1 A serve to show that, in assuming the iron losses in the armature to be proportional to the square of the induction, the error—if any—is very small. The curves O_1 B and O_1 C are also parabolas, but for equal ordinates the horizontal distances from the line O_1 D are respectively four-ninths and one-ninth of their value for corresponding points on the curve O_1 A. These are the curves which would be obtained by connecting the secondaries of the step-up transformers in series with the armature circuit, on the assumption that the losses in the transformers themselves are negligible. In the case of curve B the alternator generates two-thirds of the full volts and the step-up transformer supplies the remaining one-third. Two experimental readings were taken, through which the curve B_1 has been drawn. These readings, of course, include the losses in the transformer. The dotted curve, C_1, was obtained when the alternator generated only one-third of the total volts. In this case, as will be seen by inspection of the diagram, the step-up transformer absorbed rather more power than in the previous experiment. Indicator diagrams of the horse-power of the engine showed the same saving.

In conclusion, we must deal with the effects of the alteration of frequency which result from the reduction of speed by one-third. In the first place, the hysteresis losses in the transformers are increased by about 25 per cent., while the eddy-current losses remain approximately the same. As the C^2 R losses are small when the load is light, the resulting temperature will not be abnormally high. The question therefore naturally arises as to whether the saving in the engine is not made up for by the increased losses in the transformers. The best answer to this question is to give you the result of a careful experiment made at Altrincham. In this experiment the speed of the engine was reduced from 350 to 246, and the saving in the indicated horse-power was 16·1 per cent., which is equivalent to a saving of 17 per cent. with a reduction of speed to two-thirds full speed. It must also be remembered that at Altrincham the transformers are for the most part fixed on consumers' premises, and are therefore of small size. Under ordinary circumstances, with large transformers the saving should be at least 20 per cent. The effect of the alteration of frequency upon the meters is not serious. If Thomson meters are used, the error for a third reduction is practically negligible. With Shallenberger and Hookham meters it amounts to from 1½ to 5 per cent. We have made experiments on these meters the results of which are plotted on Diagram No. 8. In this diagram the horizontal distances represent the frequency, and the ordinates show the variations in the readings of the meters. Vertical lines are drawn at the points of normal frequency and at a third reduction. Curves are drawn for both full load and a third full load. As to the effect of the reduction of frequency upon arc lamps and alternate-current motors, there is little to be said. Our experience is that the effect upon the ordinary commercial arc lamp is not appreciable, and it will be time to consider its effect upon motors when they come into practical use.

We have endeavoured in this paper not only to make recommendations, but to support them as far as possible with figures ascertained from actual practice or experiment. We hope that some of the members present who have charge of central stations will be able to give us the result of their experience both with the difficulties of regulation of pressure and light-load economy.

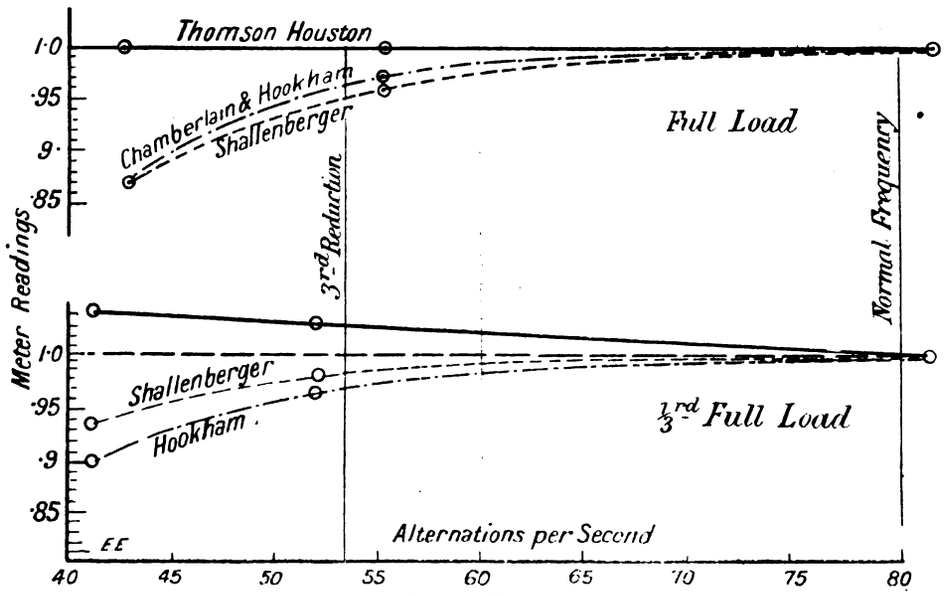

DIAGRAM No. 8.

DISCUSSION.

Mr. Rider said he should first of all say that he had listened to that paper, and read it, with deep interest, and that it was one of the most interesting papers they had ever had before them. He said that without any disparagement to any they had had. So far as the first part of the paper was concerned in dealing with the regulation of pressure, he was fully in accord with the authors. In the "Thomson" diagram the size of the feeder which worked out most suitable for that particular current came up to $^{19}/_{14}$. Taking the maximum current at 71 amperes which was given in the paper, that came to about a density of 750 amperes per square inch, which was a very safe working current for a feeder. He fully agreed with the statement that the size of the feeder should be determined by the current it had to carry, and that the drop should not be taken into account at all, as by the Thomson law the loss per mile due to the drop increased in the same ratio as the cost of the feeder. With regard to the regulation of the feeders, the method the authors had drawn their attention to was one which he (the speaker) was at present using, and he could speak of it in the highest degree. He would like to point out that it was only applicable and could only be used to keep the pressure at the feeding points absolutely constant when the different feeders and networks were distinct from each other. If they had one network and two feeders feeding at different points, they could not keep the pressure exact at those two feeding points under such conditions. They would have to cut the network, each feeder would have to serve its own network and not be connected with any other. Then they came to the second part of the paper. He was afraid that there was a good deal of debateable matter in it. A scheme which he himself was putting down had been mentioned—that was of using accumulators in connection with a motor alternator. He was not at present able to give any figures because they had not started, but the society must get his successor to give them a paper, and he would no doubt tell them more truth about it than he (the speaker) would. The various points brought before them wanted very carefully thinking about. It was recommended that for a light day-load plant a separate steam-pipe should be used. He presumed that it was meant that the main steam range should be cut off during the day. If they turned the steam on suddenly to a large steam-ring they ran the risk of breaking the joints. He believed in having steam on right up to the stop-valves of the engine the whole of the time, otherwise they might have a big smash. The scheme which was brought before them for reducing light-load losses was, no doubt, very interesting, and the figures which were given were very plausible, but he could not altogether see through them. The authors mentioned that they found a saving of 17 per cent in the horse-power when running through this augmentator, having the engine speed reduced two-thirds—that was 17 per cent. of saving; it was not 17 per cent. of the full horse-power of the engine. Supposing the engine was 100 h.p., it was a very bad plant if it took 20 h.p. to drive it at full load. If they took 17 per cent. of the 20 h.p., it only brought them to about 3·4 h.p., which was not a very great saving. He thought the best way would be to put in a much more efficient plant—say, an open-coil alternator with no iron in the armature—rather than using one with heavy losses. Surely, if an alternator with no iron in the armature was awkward to run parallel with the iron-cored machine which they had at heavy load, the difficulty would only come in at the time of paralleling to change over, as the small plant could then be stopped. It was suggested that the governors of the engines should be arranged so that they would give the variation of speed mentioned. He wished to see the governor which would enable them to

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alter the ratio one-third and still have a good range of governing. He thought if they had governors which would give an adjustable range of 5 per cent., they were good governors. This method of reducing losses only took into account the losses at the station, and did not affect the outside losses. In fact, they were going to increase the losses outside, and when their station became a large one, and the number of transformers very large, that method would be in a still worse place, because heavy losses would be going on all the time outside. With regard to the question of altering the frequency of arc lamps and meters, last year at Bolton they reduced the speed of the whole of the plant 17 per cent., not on account of the alternators, but for reasons which were purely mechanical. They brought the periods down from 100 per second to 83 per second. They had a number of arc lamps in the town, and they had not to alter the regulation of a single one—in fact, they burnt better. With regard to the meters, some of the meters were made for 100 periods, and he thought that some of them would be reading a bit out at the reduced periods. He made careful tests, and put in series with these meters other meters specially made, and he found practically no difference at the end of the quarter, taking the ordinary working load on the meters. They were Chamberlain and Hookham and Shallenberger meters. The paper said that as there were no alternating-current motors in use they need not be taken into consideration. He (the speaker) said alternating motors were in use in many stations, and if a station had only one motor in use the result of such a procedure as lowering the speed of the plant every day would be to damn the system.

Mr. Mordey, before speaking on the paper, wished to be allowed to say a word of explanation. In the report of their last meeting he read that the president had done him the honour to regret his absence, and that the author of the paper, Mr. Hammond, did him similar honour. The fault was scarcely his. He was not a member of the institution; he had had no notice of the meeting nor copy of the paper, either from the society or from the author; nor had he been invited, so that he could hardly have been expected to be present. With regard to the matter before them, he wished to join in congratulating the authors on the paper, which was an excellent one; he wished they had more such papers in London. They did not get as many of them as they ought. A great many points were touched on, but he must confine himself to a few of them only. With regard to the first paragraph, he quite agreed with the plan the authors advocated, and which was shown in Fig. 4; it was a very good one, and one which in many cases had advantages. The Brush Company used it a great deal; he thought it was Mr. Dawbarn, of his company, who first introduced it, and they found it convenient and simple. Ideas as to "banking" transformers had changed, they did not get very much advantage if they used transformers above a certain size. In a 12 or 15 kilowatt transformer they got a no-load loss of between ·75 and 1 per cent., and, no matter how large the transformer might be, the loss did not go much below that, so that there was no advantage in efficiency in having very large ones. And as to cost, the lower price per kilowatt of larger transformers had to be set against some extra cost in mains and inconvenience in handling. It might be hypercritical, but he wished to object to the capacity current being spoken of as being in advance of the E.M.F. He knew it was the universal way, but it was wrong, and it gave a wrong impression. The ordinary, or, he might say, the general explanation given of the difference between self-induction and capacity was that self-induction caused it to lead or to be in advance of the E.M.F. He once heard an eminent professor explain that self-induction was something that when the E.M.F. was applied delayed the flow of current, while capacity was something which sucked the current out before the E.M.F. was applied. This amounted to saying that the effect preceded the cause. In the interests of clearness of perception of the physics of the matter, he wished to protest against this way of speaking of the effect of capacity. What really happened was that the current was caused to lag still more by capacity than by self-induction; the capacity current lags so much behind the wave of the E.M.F. producing it that it was just in front of the succeeding E.M.F. wave. For mathematical purposes it might be convenient to consider it as in advance of the E.M.F., but it must be remembered that that did not correctly represent the fact. Instead of saying it was a quarter period in advance of the E.M.F., it would be physically more correct to say that it was three quarters of a period behind the E.M.F. The authors alluded to an excellent method of regulating shown in the various diagrams (3 and 4) He thought that the arrangement of the Manchester company or of Mr. Rider was an excellent one. It did not differ in principle from what had been seen before, but he thought it was the most practical way of applying the principle With regard to the saving of power when the pressure was raised by apparatus of that sort, he might mention a fact from his own experience. In one station with which he was acquainted it was necessary to raise the volts. He found on going into the question as to whether there would be a loss of power, that there was a saving of power. He found that by raising the volts by an augmentator, the actual power absorbed by the alternator and the augmentator was less than by the alternator alone, if worked up to the full E.M.F. He mentioned that as illustrating the effect of the apparatus, which was called a "hitcher-up." There was another point in connection with "hitching up" which was perhaps of some interest. There had been a good deal of discussion as to whether they ought to have self-induction or not in alternators. He had always thought the less they had of it the better; if for no other reason, for the very sufficient one that it spoiled the "characteristic" of a machine and made regulation troublesome and difficult. When it was working normally there was no need for self-induction, but there were perhaps certain abnormal conditions under which self-induction might be of service if the required effect could not otherwise be obtained. For example, if they had two alternators without self-induction and put them in parallel when they were out of phase, a more or less violent shock occurred. If they had attempted to lessen the shock by giving the machines a good amount of self-induction, they would lessen the shock, but the machines would regulate badly; they would have a large drop in the E.M.F. when the load was increased. With an augmentator, however, with the fine wires across the mains and the thick wire in series with the alternator they had self-induction, but it was only self-induction when the machines were out of step. At other times it had no effect on the regulating qualities of the machine. This was a valuable feature, in his opinion, in connection with the use of augmented alternators. An important matter was raised by the proposals to reduce the losses in alternators at light load. He rather agreed with Mr. Rider's criticisms on the proposals. He thought the whole point of the Diagram No. 7 was that the machine was an unfortunate one for the purpose. He did not mean to say that it did not illustrate the proposal well, but he was quite sure that the authors would not put it forward as a machine that had other good qualities than that of showing the need for reducing its load losses. He was rather in favour of reducing the engine losses at light load than the alternator losses. Of course, engines should not be run with very small loads; but in cases where it was necessary, he thought that the losses of even a large alternator were so small that the probability of using a small engine should be considered in connection with some clutching device by which the alternator would be driven in the daytime by a small engine and at night by the large one. He might illustrate what he said about the careful lagging of the cylinders by referring to a recent experience he met with when carrying out a test. As the people who built the engines were very anxious to get good results, they had every door and window closed. He was assured by the man in charge of the engine that if they had the doors and windows open there would be a very perceptible increase in the amount of fuel consumed. He suggested that they might put the engine into the feed-water tank so that the lost heat might be recovered. Upon the subject of alternators he should have liked, had there been time, to have said a good deal. He thought it was a mistake to suppose that with a machine without iron in the armature they got such a very large current on short-circuit. As a matter of fact, the current on short-circuit with an armature without iron in it was not, nor need not be, more than with machines with iron cores. In his own machines they always short-circuited the terminals with full steam on, and the current usually did not rise above three times, and he had never yet seen it more than five times the full working current. They had learned by experience that they must make machines to stand short-circuiting, and had had no difficulty in doing so without losing the good regulating quality which he thought, next to safety, was of prime importance to central-station engineers. The first thing to have after safety was a machine with the smallest possible fall of potential and self-induction. Just one word before he concluded on the subject of reducing speed. If the authors would consider that the light-load dynamo under most circumstances was running a large number of transformers, and was fairly heavily loaded, even with no lamps on, he thought that they would see that a reduction in the speed was not advisable, because the total transformer loss would increase more rapidly than the alternator loss would diminish This would be the case at least in stations where the day-load dynamo and engine were fairly proportioned to their load.

Mr. Statter said he had very little to say except that he must congratulate the authors on the paper. With regard to the Diagram No. 2, he would like the authors to tell him why they limited the money to be spent on the feeder to the copper. It seemed to him that they ought to be able to spend as much per annum on the losses in their feeders as they incurred by way of interest on the total sum expended in materials and in the labour for laying the same, plus an allowance for depreciation in getting the current from point to point. He supposed that in central-station work it was a very difficult matter to fix upon the size of the conductor, because they did not know what the requirements in the future would be. But if Thomson's law was used at all, then 10 per cent. (the authors' figures for interest and depreciation) of the total cost of the feeder and of laying it should be plotted, instead of 10 per cent. of the cost of the copper and insulation only, as plotted by the authors. In 1882 or 1883, Mr. J. E. H. Gordon was carrying out an installation at Paddington for which Messrs. Crompton supplied certain apparatus, and he (Mr. Statter) was then a pupil with that firm and it was he who informed the authors of the use of the term "hitcher-up." He was not quite sure who did the christening, whether it was Mr. Gordon or Mr. Kapp, but it was one of the two. He thought that the idea of augmentation was transmitted to Mr. Kapp, and was really due to the late Mr J. E. H Gordon alone.

Mr. Wordingham said he did not wish to take up much time, as he was afraid the authors of the paper were getting tired of being congratulated, but, if they would allow him, he would like to say that it was certainly one of the best papers they had had. Its terseness, clearness, and practical nature were very striking. The first point he wished to refer to was with regard to the fourth method of distribution described in the paper. He thought the authors were certainly right in saying that it was the most convenient and best way of distributing; at the same time, in case of a short on the mains, all the fuses might go, and it would be a terrible nuisance to get them back quickly, and there would be a very serious interruption in the supply, whereas if they had had

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the transformers in sub-stations they could very rapidly get their fuses replaced. He thought the position the authors had taken up about the most economical size of feeder quite unassailable. The current density which had been worked out in that diagram was about what he believed to be the best density they could find. It was about 750 amperes per square inch, which agreed fairly well with his own practice; he generally used 600 amperes. With regard to the device for showing the potential at the end of a feeder, which the authors said was largely used in America, he believed that that was due to Dr. John Hopkinson's method being introduced, and patented by him many years ago. He thought that that might be of interest to mention, as they did like to get their ideas from America. The same consideration that occurred to Mr. Rider about the steam-pipe occurred to him also; he did not think it was really practicable to shut off the main steam range for any part of the day, unless they were sure to have ample time to have it on again. If they had a sudden demand, and the range was shut off, the result would be disastrous. He might say a word with regard to the reliability of the ejector condensers. At the Manchester station they had them on all their engines, and they had never had the slighest trouble with them, and they had given excellent results.

Mr. Nisbett said he would like to protest against Diagram No. 2, which in his opinion was entirely misleading, owing to the fact that the cost of laying the mains, armouring, making good the pavement, etc., had not been included. It was obvious that because these were standing costs, whatever size of mains they laid, they should not be left out, for when the main was worn out, the armouring was worn out, and the trench was also worn out, and therefore depreciation on these should be added to that on the cable. This allowance would make the economical current density very much higher than the authors supposed. Taking the same example as the authors had done—viz., an average current of 26 amperes—to the cost of the cable must be added that of the armouring and trenching; the economical section of copper would then be ·03in. instead of ·1in., so that at load times that cable would be working at a density of 2,500 amperes per square inch. The authors, on the other hand, had taken the cost of energy lost in the cables at 1½d. per unit, whereas they had also taken the energy lost in driving the pumping and other plant at something like ¾d. per unit, because they said the standing costs were not in such case chargeable. Of course the same reasoning applied equally to the losses in the mains, it being only the coal bill which was increased. If now they add to the interest and depreciation on the cost of the cable the amount due to the trenching, armouring, etc, and reduced the cost per B.T.U. lost in the mains to ¾d. instead of 1½d., it was at once obvious why Thomson's law was not more generally adopted, at any rate for high-tension mains, for the law showed that the economical section was such that if it were used the mains would be red hot at load time every evening. There were one or two points in connection with the system of distribution marked D (Diagram No. 1). He could not altogether see that it had many advantages over the system C. Mr. Wordingham had raised a point about the difficulty of getting at fuses in transformer pits. That was a very important one. The contacts on transformers were very apt to get loose. He considered the scheme with sub-stations far preferable. All the contacts could be seen and examined periodically with ease, and the facilities for switching transformers in and out as the load varies were better. Both systems, however, had their uses. Then the authors laid too much stress altogether on the amount of capacity current. They calmly talked about a capacity current of 10 amperes on a feeder. That would mean that the feeder would have to consist of 25 miles of $^{19}/_{18}$ cable. He thought that they had put down to the cables that which belonged to the transformers. He agreed with the authors as to the necessity for regulation on feeders, and the apparatus designed by them seemed to answer its purpose admirably. With regard to the remark as to the cost of pressure wires, these are not so great as the authors seemed to think, as a pair of pressure wires can be put into a high-pressure cable for about £35 per mile, which was not a very serious item. He did not agree with the authors as to the economy of injectors. He thought that they rather contradicted themselves as he had read it. Apparently they had overlooked the losses due to the condensation of steam and the necessary re-evaporation of the water; the pulsometer pump was an instance of that, and although a useful form, he did not think anyone would say it was a more economical form than a barrel pump. It seemed to him that a good pump of the ordinary type driven by an electric motor was far and away better than any injector.

Mr. Heaketh said he thought that engineers at last saw the futility of seeking for an absolutely uniform day load, and the authors were now attacking the question at the right end in seeking for high efficiencies at low load instead. Certainly any central-station engineer who settled down to solid work after hunting the phantom of a day load would find that those little economies were very difficult to obtain, even more difficult perhaps than the day load. With regard to the question of boiler efficiencies, the efficiency of a boiler increases as the duty was lowered. He obtained about 9·5lb. of water per pound of coal when evaporating 9,000lb. of water; but reducing the evaporation to 6,000lb. of water, he got 10½lb. of water per pound of fuel, showing a great advantage from not pressing boilers, or using rather large boilers for low duty. As to cutting off the steam range, he found that the losses in the steam-ring were getting very considerable, and tried the natural expedient of cutting it off during light-load time, but, unfortunately, the cost of repairing joints was double the cost of keeping the steam up. There was also a great deal of loss in the use of feed-water heaters. It was a very common practice to put a large feed-water heater in the main exhaust-pipe, and to expect that they were going to get the full advantage of the whole of the heat units in the exhaust steam. That was a very great fallacy. The same economy would be obtained by using the exhaust steam from their pumps to heat the feed water, and condensing the main exhaust. If they so used the exhaust of their steam-pumps, the losses in driving feed pumps by steam were not so great as they would at first appear. The steam taken by the centrifugal pump mentioned by the authors would not be 1 per cent. of the total steam taken by the engine, although its power might be 1 per cent., but the steam would be something between 5 and 10 per cent. The method of reducing engine losses by reducing the speed was rather drastic, and he would rather use an alternator without iron in the armature. They had one or two motors at Blackpool, and to alter the periodicity every day would cause such trouble that they would have no peace at all. One of the greatest requirements in central-station working was absolute confidence of the consumers in the supply, and if they were going to vary their speed every day, of course the consumers would never put up with it. As regards the low-tension distribution in scheme D, he said that they had experimented with short-circuits recently at Blackpool to see the effect, and found that the fuses acted immediately, and cut out the faulty section.

Mr. Lindley said that, on the question of the reduction of the speed, he thought that, apart from the difficulty which Mr. Rider had foreshadowed with the springs, there was the difficulty that they would have to stop the engine to alter them again before it could be put in parallel with the machines. He would like to suggest what might be done to meet that difficulty. It was not advisable to reduce the speed of the engine providing they could put up with having the alternator running at full speed. The whole thing really centred on how much they could reduce the power of a compound engine without seriously falling off in the economy. This in a suitable engine should be one-fifth of full load, and then there would be no necessity to reduce the speed of one of the smaller units in order to operate the day load with economy. He might suggest to Mr. Mordey, who had been kind enough to offer to teach them something about putting engines into feed-water tanks, that he, Mr. Mordey, might have put the steam-pipes in also, so that they would get a higher efficiency still.

Mr. Still, in reply, said that Mr. Cowan and he had been prepared to meet with a good deal of opposition, as there was no doubt they had laid themselves open to attack from various quarters. The way in which the paper had been received was a very agreeable surprise, and he wished to thank those present, both on his own and on Mr. Cowan's behalf, for the kind way in which they had spoken of it. He proposed to reply to the points raised on the first part of the paper, and Mr. Cowan would then deal with the second portion. He was glad to learn that Mr. Mordey had found the system of distribution shown at D in every way satisfactory; it certainly seemed to him very superior to the system of sub-stations with a heavy low-pressure network, which neither from the point of view of economy or of regulation made proper use of the many advantages of a high-tension supply. With regard to Mr. Wordingham's remark that in the case of a short-circuit all the fuses might blow, this was only applicable to the case in which all the secondaries of the transformers were connected in parallel by closing the switches marked S, which would most decidedly be the wrong thing to do. In reply to Mr. Statter, and notwithstanding Mr. Nisbett's great confidence in his own assertions on the subject of Thomson's law, it was quite evident that in working out the most economical cross-section for a feeder, the capital cost they had to consider was only that portion of the total capital outlay which depends upon the amount of copper in the feeder. Mr. Nisbett admitted that the laying of the mains, making good the pavement, etc., were standing costs and did not depend upon the size of the cable, and that was the assumption which had been made in the paper; but Mr. Nisbett still thought that the amount of those costs should determine the size of the feeder. Why, then, should he stop at the culverts and trenches and not include transformers and sub-stations, or even the cost of the generating station itself? The wearing out of the culverts or pipes and the cost of keeping them in order was a question of the choice of the system, not of the exact cross-section of the cable to be used. If the extra labour of drawing in a heavy cable was worth considering, it should undoubtedly be taken into account, as also should be the increased cost of the culverts, etc., if they had to be made larger in size as the cable increased in weight. The most convincing argument of all in support of their contention that these capital costs which were constant could not affect the economical side of the cable was one which every mathematician would appreciate at once. In order to obtain the minimum value of any quantity which was a function of another variable quantity he differentiated both sides of the question, and since the differential coefficient of a constant was zero there could be no trace of that constant left in the differential equation, and it was therefore quite impossible that it should influence the size of the feeder. Mr. Nisbett mentioned excessive temperature rise as a possible limit to the size of feeders worked out on Thomson's law, but in practice that was not found to be the case, and for that reason it had not been referred to in the paper. If a dangerously high temperature was likely to occur at times of full load, two or more cables would have to be laid side by side, or the cross-section of the single cable increased, according to which method proved to be the most economical. Mr. Nisbett also spoke of feeders as being buried in the ground, but this was bad practice; they should be always drawn into pipes or laid in culverts, where they were easily accessible and could be added to when

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required. With regard to the 10 amperes of capacity current referred to in the paper, that was merely assumed in order to work out an example, but as a matter of fact a capacity current of eight to ten amperes, or even more, was by no means impossible or unheard of; and Mr. Nisbett seemed to forget the existence of rubber-insulated cables, which, with their thin dielectric of comparatively high specific inductive capacity, took far more capacity current than paper-insulated cables. The current due to the capacity of the cables was a totally different thing to the magnetising current of the transformers, and there could be no confusion between the two. Mr. Mordey, on the subject of capacity current, objected to its being spoken of as a quarter phase in advance of the E.M.F. This, however, was the usual way of expressing what was really the truth, and the question was, after all, only one of choice of terms. There were undoubtedly two ways of expressing one and the same thing, and it was, of course, quite correct to speak of the current as lagging three-quarter phase behind the E.M.F., but when dealing with the phase differences between two periodically varying quantities, there was no beginning and no end to be considered; and the displacement of one of those qualities with regard to the other could surely be expressed with equal accuracy either by stating the amount by which it was in advance of the other, or by the amount by which it lagged behind.

Mr. Cowan, in reply, said that Mr. Rider, Mr. Wordingham, and Mr. Nisbett had all criticised the suggestion that steam ought to be cut off the ring-main during the hours of light load, as they did not believe it was practical on account of the failure of joints likely to arise. If that was the case, why was it that cylinder-cover joints did not give similar trouble? He thought that if the joints were properly made and the steam-pipes properly suspended, such trouble ought not to occur. Of course, great care must be exercised in admitting steam to a comparatively cold range of pipes in the matter of draining, etc. It could not be done in a hurry. There seemed to be considerable doubt in the minds of many of the speakers as to the advisability of reducing the speed of the engine. Mr. Mordey and Mr. Lindley seemed to think that the object was to save losses in the alternator. That was not so; the saving effected was only in the engine; nothing was saved in the alternator. A good deal was made of the increased losses in the transformers which would, of course, arise with the lower frequency. That point had been, he submitted, effectually answered in the paper. When the time came when the day-load plant was loaded with a very large number of transformers, the only saving in the reduction of speed might be in wear and tear, and it might not be considered worth while to continue the practice. He did not think there would be any great difficulty in designing a governor which could be adapted to control the engine at two different speeds. The tension of the springs should not be altered, but the leverage at which the weights acted; and the alteration must, of course, be made by hand without stopping the engine. Mr. Lindley preferred an engine which gave nearly equal economy at all loads, from one-fifth to full load. But the question was not one of thermodynamic efficiency only, but brake horse-power compared with steam consumed. An engine which gave nearly equal economy at from $\frac{1}{5}$ i.h.p. to full load was the right kind of engine to instal for light load; but the saving due to reduction of speed was effected with that engine as well as with any other. On the question of the results of the reduction of frequency from the consumer's point of view, the only point raised was the effect upon motors. In reply to that, he would only say that he held the opinion, and always had held it, that motors were unfit for lighting circuits, especially alternating-current motors, with their large idle current. He prophesied that if motors became popular, the electric light would become unpopular. It was impossible to regulate properly with alternating-current motors on the circuits. Having come now to the proposed method of reducing the alternator losses—viz, by halving the induction—he was glad to have Mr. Mordey's support as to the saving being an undoubted fact. At the same time, Mr. Mordey had misunderstood Diagram No. 7, the curves on which were drawn to show that the losses in alternators varied nearly with the square of the induction. The plotted experiments were made with an iron-cored alternator, but experiments with Mr. Mordey's own alternator would follow the same curves—indeed they would proximate more nearly to the true parabolas drawn, because the hysteresis loss peculiar to an iron-cored alternator did not vary quite as the square of the induction. The objection to Mr. Rider's suggestion of putting an alternator down for light load which had no iron in the armature was chiefly its first cost. They thought it important to save the first cost and space occupied by a special light-load plant. Mr. Rider seemed to think that 3·4 h.p. was hardly worth saving (it was more than that); but even 3 h.p. or 4 h.p. for 16 hours a day for 365 days in the year cost an appreciable amount, and was certainly worth saving in a small station. Mr. Mordey said that it was possible to design his alternator to give on short-circuit no more current than an iron-cored. Quite so; but what then became of the characteristic? It was possible, also, to design an iron-cored alternator with as good a characteristic as Mr. Mordey's—at a price. Mr. Nisbett thought that they had overlooked the losses in an injector due to condensation of steam. He thought Mr. Nisbett had hardly done justice to the remarks made under that heading in the paper. They had given a great deal of consideration to the whole subject, and had come to the conclusion that nothing but careful and authoritative experiment could settle the point. They had looked up crowds of reference, but had been unable to find any reliable results of experiments. He would ask Mr. Nisbett to reconsider the question, bearing in mind that all the heat in the steam went back into the boiler. Mr. Still had replied very fully to the criticisms of Thomson's law, but there was one point. Mr. Nisbett contended that if $\frac{3}{4}$d. per unit was taken as the cost of energy consumed by the auxiliaries, that 1$\frac{1}{2}$d. ought not to be taken when considering the effect of the losses in the mains, but $\frac{3}{4}$d. The two problems were, however, entirely different. In the first instance the question to be settled was whether to drive the auxiliaries by the main engine. The main engine was running in any case, and therefore, for the purposes of comparison, its standing losses would not be taken as chargeable against the auxiliaries; whereas the standing losses of a separate plant must be—that was surely good logic. But in the case of the losses in the mains the problem was different; there was no alternative to consider, and all losses, as in meter shunt, transformers, mains, etc., should be charged at the full works cost, including fuel, oil, wages, etc., based upon the output registered by the station, not the consumers' meters.

Mr. Fawcus, in rising to propose a vote of thanks to Mr. Cowan and Mr. Still for their paper, said he would just make only one remark about the steam-pipes. He was rather surprised to hear Mr. Rider and Mr. Hesketh tell them that they could not keep their steam-pipes tight, and he pointed out that there were thousands of plants where the steam was shut off every day, and if electrical engineers could not do what steam engineers could, they had better learn how to. He then proposed a vote of thanks to Mr. Cowan and Mr. Still, which was carried unanimously.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

April 14, 8 p.m.—At the Institution, Great George-street, Westminster. Ordinary meeting. "The Thirlmere Works for the Water Supply of Manchester," by G. H. Hill (member). "The Vyrnwy Works for the Water Supply of Liverpool," by G. F. Deacon (member). At this meeting the monthly ballot for members will be taken.

April 15, 3.30 p.m.—At Great George-street. Special general meeting to consider alterations in the by-laws.

April 17, 8 p.m.—Students' meeting. "Recent Developments in Lighthouse Engineering," by N. G. Gedye (student).

Institution of Electrical Engineers.

April 16, 8 p.m.—At the Institution of Civil Engineers, 25, Great George-street, Westminster. Ordinary general meeting. Discussion on Dane Sinclair's paper on "Telephone Exchanges and their Working."

Northern Society of Electrical Engineers.

April 13, 8 p.m.—At the Palatine Hotel, Manchester. Ordinary general meeting. Lecture and demonstration of the new photography, with lantern views, by C. M. Dorman (member). After the lecture the members of the society will visit the Manchester Corporation battery station, on the invitation of Mr. C. H. Wordingham.

Institution of Junior Engineers.

April 17, 8 p.m.—At the Westminster Palace Hotel. Paper on "Dredgers," by W. J. Hunter.

Society of Arts.

April 13, 8 p.m.—At John-street, Adelphi, W.C. Cantor lecture on "Precious Stones," by Prof. H. Miers.

April 15, 8 p.m.—"Early English Organ Writers," by B. Horner.

Royal Meteorological Society.

April 15, 7.30 p.m.—At the Institution of Civil Engineers, Great George-street. "Mean Amount of Cloud Each Day, from 1841 to 1890," by William Ellis. F.R.S.; "Atmospheric Dust Observations," by E. D. Fridlander, B.Sc.; and "Analysis of the Greenwich Rainfall Records, with reference to the Declination of the Sun and Moon," by Major H. E. Rawson, R.E., F.R.Met.Soc.

Dundee Institute of Architecture, Science, and Art.

April 15, 8 p.m.—At the Albert Institute, Dundee. Ordinary meeting and exhibition of drawings.

Royal Institution of Great Britain.

April 13, 5 p.m.—At Albemarle-street, Piccadilly. General monthly meeting.

April 16, 3 p.m.—Lecture by Prof. Dewar on "Recent Chemical Progress."

April 17, 9 p.m. Lecture by Prof. G. Lippmann on "Colour Photography."

Russian Telegraphs.—According to the *Elektrotechnische Zeitschrift*, the Russian telegraphic receipts for the year ending January 1, 1896, were 12,377,393 roubles, or about £2,061,325. This is a considerable advance on the previous year, when the figures were 11,633,539 roubles, or £1,890,450.

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THE

ELECTRICAL ENGINEER.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XV. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

BOILERS.

The question as to what type of boiler is most suitable for generating steam for electric light stations is one that cannot be answered without a careful study of the subject. In this department, as in many others connected with the electric supply in towns, certain early stations are apt to be copied without due consideration of the altered climatical conditions. An article on the subject recently printed in the *Engineer*, and given elsewhere in our columns, assumes that this has been done. The writer compares the boiler practice in mill work with that in electric light stations, and concludes that Lancashire boilers should be more widely used. We endorse this opinion, but protest that the so-called craze for water-tube boilers was not the result of haphazard, but rather the outcome of careful study. The condition of steam generation and the demand for power in mill work cannot be compared to that in electric light stations. In the first case the load is fairly constant throughout the working day, the fluctuations rarely exceeding 25 per cent. of the average output. On the other hand, the demand for steam in an ordinary electric light station varies largely at different times in the day, and at light load the output is often under one-twenty-fifth of the full load. Now, when these changes can be approximately foreseen, the Lancashire boiler will meet the requirements of the town; and the fact that this type of boiler has been solely used in such stations as those at Bristol, Newcastle-on-Tyne, Blackpool, Walsall, Stafford, Manchester, and many other places, shows that the water-tube boiler has not been blindly adopted. The writer of the article will be surprised to hear that of the provincial stations an ample majority are equipped with the Lancashire type of boiler. In the electric light stations in London the water-tube boiler has carried all before it, and we would uphold this practice. The chief reason for this result has doubtless been its quick steaming properties. The electric light supply must necessarily be continuous, and the sudden demand when a fog arises in London could not be met with Lancashire boilers without considerable loss due to boilers standing under steam. There is no doubt but that the large water spaces in these boilers give an advantage when dealing with a sudden and temporary increase of load, but the same storage effect acts prejudicially when boilers have to be brought quickly up to the working pressure. Again, while for large and fairly even demands the Lancashire type has the advantage in the annual expenditure on repairs, it must not be forgotten that ground space in the Metropolis is extremely valuable, and that the water-tube boiler scores heavily in this respect, and also in ease of erection when the ground space and approaches are cramped. The efficiency of a boiler can, as is well known, be largely increased by a decrease in the rate of steam generation, which fact renders the comparison of different types of boilers a difficult matter. Thus, working a large number of boilers lightly would appear to be more advantageous than keeping a few boilers working at their full load.

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The losses due to radiation from the boilers and their settings would, however, neutralise the apparent gain to a great extent. Although efficiency thus needs care in comparison, the item for annual repairs is always ascertainable, and from it useful lessons may be drawn in support of the country practice in boiler work for electricity stations. The gist of the whole matter lies in the load diagrams, which in London are very erratic. The promptitude with which these unexpected irregularities are met by the staffs of our London supply stations is worthy of every commendation, but the strain occasioned by the sudden demand could not be met by the ordinary mill practice.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE SNOWDON RACK RAILWAY.

SIR,—Last Monday's lamentable accident on the Snowdon Railroad will, perhaps, invest with a melancholy interest the article you were good enough to publish under my name a week ago, though I fear the developments in rack lines therein anticipated will now be delayed for some time as a consequence of the runaway on Snowdon.

One can hardly attempt at present to suggest what may have been the real cause of the accident, especially in view of the Board of Trade enquiry, at which full particulars will doubtless be forthcoming. The so-called "official" account is certainly not clear or consistent: it speaks of the rack as being damaged, although both the carriages of the first train and the second train as a whole were pulled up by its means. Moreover, it is extremely difficult to believe that the first engine mounted the rack whilst still on the line and under control. The engine must have been travelling at too high a speed, probably beyond control, and then mounted the ordinary rails at a curve, thereby getting out of gear with the rack. Such an occurrence had not happened before, and is hardly likely to happen again.

I must not theorise, however; my chief object in writing is to point out that if the motive gear had been electrical, and therefore placed in the usual way under the passenger car framework or on the trucks, there would have been much less danger, even in case of a momentary runaway. For emergency stops on a heavy locomotive and train under such conditions, it is usual to employ an arrangement which puts on the rack brake automatically when a certain maximum speed is reached. I do not know whether this device came into play on Monday; it could hardly find an opportunity to do so if the locomotive left the rails before reaching the maximum speed permissible. That the cars should have attained a high speed and yet kept on the line shows, I think, that their construction was such as to allow them to run safely where the engine could not.

If any moral may safely be drawn—pending more details of what actually took place—it would seem to be the following: with railways of this character, motorcars as employed on all electric lines have great constructional advantages for ease of braking and controlling generally in regard to the somewhat remote possibility of excessive speed, as well as in ordinary working.—Yours, etc.,

London, April 8, 1896. FRANK B. LEA.

THE INSTITUTION BALANCE-SHEET.

SIR,—I have read your article of the 3rd inst. on the "Institution Balance-Sheet" with mingled astonishment and pain.

With the misstatements of fact I will not deal, as they will in due time be corrected by a perusal of the *Journal*, but there is a suggestion put to your readers—evidently a reflection of your own opinion—which I cannot allow to pass without protest. The said suggestion appears in this form: "We should much like to know if the real juice was not the wish to pass a vote of censure on the honorary treasurer?"

In the first place, there was no wish to pass a vote of censure on anyone, as was evidenced by my repeated offer to adjourn the debate or to withdraw the amendment.

In the second place, I am not aware that the honorary treasurer was in any way responsible for the form of the balance sheet or for its accuracy.

In the third place, the honorary treasurer is a gentleman with whom I am, and have been for several years past, on terms of friendly intercourse.

Of course, there have been differences of opinion; it was impossible for it to have been otherwise, considering the wide range of subjects which has come under review, but in this latter half of the nineteenth century it would be childish to make such differences of opinion a ground for the abrogation of personal esteem or for the total disregard on my part of those sentiments of admiration and gratitude towards the honorary treasurer of the Institution which I have long felt, and which I endeavoured feebly (and it now appears ineffectually) to express to the members present in the course of my address on the balance-sheet.

It may interest you and your readers to learn that, so far from the time having been wasted which was accorded to the discussion of fundamental matters at the annual meeting on December 12, it has resulted in the drafting of numerous amendments to the articles of association—which amendments, with the concurrence of my friends, I took the liberty of bringing under the notice of the President in preference to calling a general meeting for their consideration. The result is that the said amendments have been submitted to a committee of the Council which included the honorary treasurer, and their report which is now before the Council is, I have been informed, generally in accord with the spirit of the amendments submitted.

I am sure, Sir, that you are actuated by motives which have no other object than the support of the Institution so far as it endeavours to fulfil the duties for which it was created, and I respectfully submit to you the suggestion that there may be other members or associates who are or may be actuated by similar or at least not less honourable motives.—Yours, etc.,

JOHN S. RAWORTH.

[We cannot say that Mr. Raworth's letter alters our impression of the true state of affairs. He admits, in the first place, that the amendment was a vote of censure, and that he called for a division because the waste of time was objected to by the President. Secondly, we can hardly imagine what Mr. Raworth's ideas of the duties of the honorary treasurer are. The gentleman in question took a lively interest in the remarks of Mr. Raworth, and showed his connection with the balance sheet by one or two interruptions. Again, if the Council so readily acted on the suggestions brought forward on December 12 without a motion having been put, Mr. Raworth might at least have trusted the present small matter in their hands. We repeat that the whole of the "juice" spoken or printed on the subject of the amendment could have been done ample justice to in the course of a five-minutes' speech.—ED. *E. E.*]

BIRMINGHAM ELECTRIC TRAMWAYS.

In our issue of August 15, 1890, will be found a description of the Bristol-road electric tramway, which forms a portion of the Birmingham Tramways Company's system—in fact, that portion which is worked electrically. The engineers, as will be seen from our description, were Messrs. E. Pritchard, M.I.C.E., and Joseph Kincaid, M.I.C.E, who designed the permanent way outside the city boundary and also the depôt and the electric installation. The recent meeting of municipal engineers at King's Heath had as part of its programme a visit to Bournbrook, the depôt for this Bristol-road section of the tramway. This visit gave us another opportunity of inspecting a line

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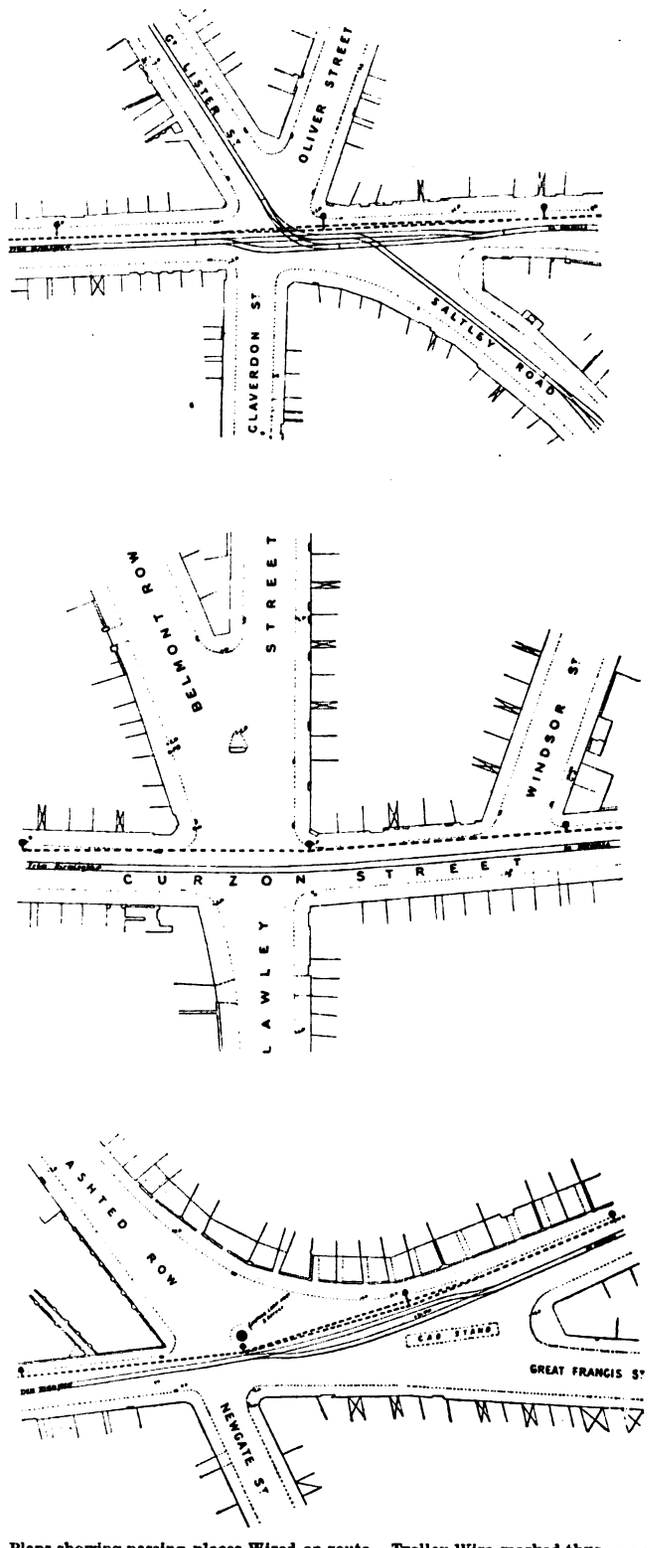
which has been worked on the accumulator system since its start to the present day. So far as the works themselves are concerned there is very little change, and so far as the system is concerned there is also very little change except that various types of accumulators have been tried, and it has been found that, no matter what type of accumulator is used, the expenses of the line are so great that profits vanish ; in fact, if an examination be made of the balance-sheets of the Birmingham Central Tramways Company during the past few years, it will be seen that while the steam department, the horse department, and cable department all had a balance to revenue account, the electric department, with the exception of one year, has had a balance on the wrong side, and even in the case where the balance seems on the right side, that probably arises from the way in which the accounts are made, in that the expenses do not include the Corporation charges. However, we have dealt with these balance-sheets periodically as they were issued, and it is needless for us to consider them again. We may, however, venture to give a few details regarding the line so far as we can obtain information of the working by means of the accumulators at the present time. The accumulators now in use are of the Chloride Electrical Storage Syndicate's manufacture, which have been installed for about 18 months. The syndicate's contract with the tramway company is based on the car mileage run, with a stipulation to the effect that 17 batteries shall be maintained in an efficient state. We may add here that the length of line worked is 3 miles 153 yards double track, and the number of cars running over it at any one time varies with the time of day, sometimes the number being five, and at others nine, while three are always kept in reserve. Various experiments with different types of batteries have shown that each line wants to be treated on its own merits, having regard to the weight of the cars, etc., and in order to calculate the best efficiency and the longest life for each kind of car the number of cells contained in the batteries has been varied. Batteries weighing from $1\frac{3}{4}$ to $2\frac{3}{4}$ tons, on cars weighing—without batteries, but with passengers—about 10 tons, have been tried. We understand that the 17 batteries of 72 cells each which are now at the depôt are of the R Chloride type, and each battery will run for about six hours when new. The battery is not considered inefficient until it refuses to do less than two hours' run without recharging. So far as the life of the plates is concerned, this type only having been installed for about 18 months, and having regard to the different patterns which have been experimented with, sufficient data is not forthcoming to justify any definite statement. As regards running with accumulators, the Chloride Company hold that it is the proper course to adopt where there is not a sufficiently frequent service to justify the instalment of an overhead-wire system.

Previous to this, Epstein and also E.P.S. accumulators were given a trial. Mr. Epstein has more than once given full details as to the working of the accumulators which bear his name, the gist of which we may again venture to reproduce. It was about the beginning of 1892 when they were first installed, and as the plates of this type are composed of a single lead casting in the form of ridges, supported by a web, and, moreover, contain no straps or built-up parts, they are claimed to be particularly suitable for withstanding the shaking and rough usage incidental to tramway work. The history of the batteries in working at Birmingham was carefully recorded by the Epstein Company, and, as a result, it was found that 12 sets of 92 cells made an average car mileage of considerably over 15,000 miles without requiring renewal. The cells were supplied under a maintenance contract calculated at $1\frac{1}{2}$d. per car mile. With a run of 15,000 miles this gives something more than £93, and as the number of cells per car was subsequently reduced from 92 to 72 it amounts to just under £1. 6s. per cell. Now, as the cost of such a cell when the trade discount is deducted would be about £2. 8s. for the two plates, the ebonite casing, and all accessories—while so far as renewals are concerned there is practically only one plate to consider—it will be seen that this arrangement was one that should have proved profitable to the contractor, and the rate mentioned of $1\frac{1}{2}$d. per car mile run might well be reduced. Using the Epstein cells, the cars were run with great regularity under circumstances of great difficulty owing to the severe winter of 1892-93 Indeed, so far as concerns keeping their times the cars showed a decided superiority to those that were running on other systems in Birmingham at the same period.



Plans showing passing places Wired on route. Trolley Wire marked thus - - - -
• L P signifies existing Lamp-posts.

For reasons, however, which doubtless seemed good to them, the Board of the tramway company largely transferred their orders to the Electrical Power Storage Company, but gave their accumulators up after a comparatively short time, and tried the Chloride Syndicate. The latter company, as we have mentioned above, instead of selling the accumulators right out, entered into an agreement on the basis of the car mileage worked, and the cars are still being run on those terms. With the Epstein cells, we may add, a total car mileage of 188,000 was run at a cost of

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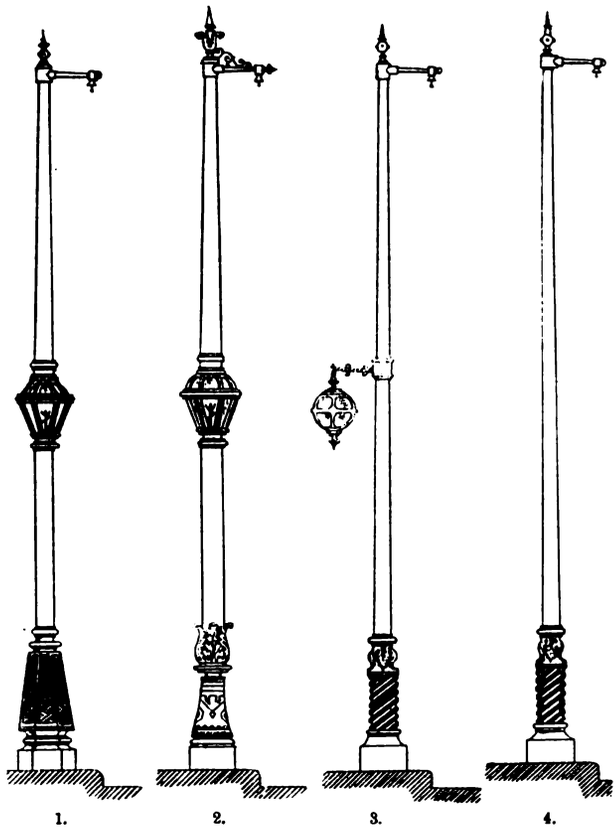
about 1s. 3d. to 1s. 2d. per car mile, a rate which Mr. Epstein thinks, under present conditions, might be somewhat reduced. As regards the E.P.S. cells there is no information available. The present contractors consider the conditions of running on the Bristol-road line are very much against the success of the accumulators from a financial point of view, the cars being very heavy and inefficient. With better cars and motors, it is claimed the work could be done more economically. Then, again, the Corporation, for the three odd miles of double track, exact a rental of £2,000, whilst the cable line has to pay about £1,000 for double the mileage. The actual cost for batteries works out at less than 10 per cent. of the total cost per mile run.

The Birmingham Central Tramways Company, Limited, practically have the monopoly of the tramway and omnibus services through the city and suburbs of Birmingham. The former services extend over some 43 miles of line, and although horse and steam traction at present predominate over this extensive system, there are also two lines which have been satisfactorily worked for some years past by means of cables—besides the line



Submitted Designs for Poles.

worked electrically which we have spoken of at some length above. The time, however, seems within reasonable distance when, besides these several modes of traction, the overhead conductor system of electric propulsion will also be represented at Birmingham. Some time ago the tramways company decided to equip a portion of their lines for working on the overhead system, and in order to more readily obtain the consent of the City Council—which now, by-the-bye, has been obtained—to the proposed scheme, Mr. Alfred Dickinson, A.M.I.C.E., engineer to the company, collected a mass of information in the shape of letters *re* the South Staffordshire electric tramways. The object of the information so collected was to demonstrate the fact that although strenuous opposition was offered to the adoption of an overhead conductor system of electric traction on the South Staffordshire lines, objection to the service no longer exists to any great extent. A glance through the letters in answer to Mr. Dickinson's enquiries from some of the principal residents in the Walsall and Wednesbury districts shows us that the general census of opinion obtained was entirely in favour of the overhead system; their purpose was therefore well served. These letters, together with a few illustrations and drawings—some of which we reproduce herewith—were placed before the Public Works Committee, the better to guide them in making their report to the Council. The line proposed to be equipped is that running between Birmingham and Nechells, a distance of 2 miles 1 furlong 117 yards. It is at present worked by horses, though the gradients are by no means inconsiderable, the fall at the Birmingham end being as much as 1 in 16. The permanent way consists of a single track of rails, with cross-overs or passing places at intervals, and is in such excellent condition that it is not proposed to relay the metals, but simply to bond them, that they may be utilised as a return. The accompanying drawings show at a glance the proposed method of wiring the principal passing places; it will be seen that the supports necessary for the trolley wire are very few. In the proposed method of running the trolley wire, etc., the engineers, Messrs. Alfred Dickinson and Co., have aimed at an improvement on the South Staffordshire system. The trolley-wire poles, carrying gas-lamps, will be placed in the positions occupied by existing lamp-posts, and will therefore serve a double purpose. We reproduce several submitted designs of these proposed combination poles, but the one most likely to be finally approved is, we understand, an amendment on the No. 3 design, which, instead of the one lamp as depicted, will carry a couple, one branching out on either side. Moreover, the lamps, instead of being globular in form, will be of similar design to those at present in use. It is intended to give the trolley arms great radial play so as to reduce the length of the brackets supporting the trolley wire to a minimum. The actual distance between the trolley wire and pole will be reduced by this means to an insignificant 18in., so that the brackets will hardly be noticeable. The trolley wire itself will be of the same gauge as that on the South Staffordshire line—namely, 312·5 mils, and a feeder will be connected to it at a point about 1¾ miles distant from the depôt. It is proposed to use the Etna type of insulator throughout. Lines worked by steam cars intersect the Nechells route, so that in case of necessity either horse or steam cars could be substituted for the electric ones, the gauges being similar. With regard to the necessary plant for working the line, it is proposed to instal at the company's Nechells depôt—where ample accommodation exists without erecting new buildings—a couple of 100-i.h.p. under-type engines, driving by means of ropes a similar number of 100-kilowatt dynamos, working at 500 volts pressure. Either of the units composing this duplicate set would be capable of comfortably working the line, so that one set of machinery would always be held in reserve. An attempt is to be made to convert existing horse cars for service on the line, and to this end 10 cars suitable for conversion are to be taken in hand and equipped with motors, etc. Offers have already been obtained by the tramways company from firms willing to instal the necessary plant, etc., and to work the line for six months, after which period the tramways company to have the option of taking over the plant at a price previously agreed upon. The whole matter is likely to be settled and the work commenced very shortly. The scheme, however, must be regarded in the light of an experiment, and as such its progress will be watched with interest, expecially in that successful issue would probably lead to the conversion of many more miles of the Birmingham tramways to that of the electrical system. We therefore heartily wish success to this—Mr. Alfred Dickinson's—proposed conversion scheme.

CAN AN ELECTRIC CIRCUIT BE OPENED WITHOUT AN ARC? *

BY A. J. WURTS.

The opening of an electric circuit is ordinarily accompanied by an arc which causes more or less damage to the switch terminals. The extent of this damage is in general dependent on the amount of current flowing and on certain characteristics of the circuit and generating apparatus.

Up to very recent times electric circuits have been handled

* From the *Electrical Engineer* (New York).

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with switches constructed without special reference to arcing, the deteriorating action of the arc not being sufficient to warrant special constructions. With modern lighting and power-transmission circuits, however, the problem has assumed quite different proportions, so that not only are ordinary switches rapidly destroyed in the handling of these circuits, but an element of danger is also introduced To-day electric arcs 6ft. long are not uncommon.

While experimenting some time ago with static discharges I had occasion to pass a small discharge across a $\frac{1}{32}$in. gap between electrodes which were placed in a heavy glass tube filled with oil and securely corked at either end. Much to my surprise, at the time when the discharge occurred, the glass tube was broken into small fragments; it did not burst as by an explosion, the tube simply fell to pieces. The experiment was repeated a number of times with the same result. I subsequently analysed the experiment as follows:

An electric arc requires space. The glass tube was filled with an incompressible fluid possessing considerable inertia. An arc which might form within this fluid would be obliged to displace the fluid, which, in turn, being incompressible, would force out the walls of the containing vessel; the latter being brittle were broken into fragments. The force which broke the vessel was the E.M.F. which forced the arc across the spark gap. The elastic corks could not play the part of cushions and thereby save the tube because the displacement of the oil was sudden—the oil was not pushed away by the arc, but knocked away, as with a hammer—and because the inertia of the oil between the arc and the corks was greater than that between the arc and the walls of the tube—in other words, the force became active in the direction of least inertia. Reasoning further, it seemed that if the vessel had been relatively stronger than the E.M.F. the arc could not have formed—in other words, it seemed as though the elements were at hand for the construction of a switch capable of opening an electric circuit without an arc.

Following out these ideas, I constructed an ordinary electric switch of about 100 amperes capacity, which was suitably located in a sealed cast-iron vessel filled with oil. On placing this switch in a 500 volt direct-current circuit, I opened and closed the switch some eight or ten times on 30 amperes, and upon removing the stopper from the cast-iron vessel was surprised to see the oil spurt. On examining the oil I found it had been considerably carbonised. The accumulation of pressure and the carbonisation of the oil indicated the formation of an arc at the switch terminals, which for a time puzzled me considerably, as the formation of an arc had not entered into my calculations. On repeating the experiment I neglected to replace the stopper, with the result that when the switch was opened a column of oil was forced into the air about 6ft. high. Testing again with the vessel closed I detected a slight gurgling sound when the switch was opened.

Being still puzzled, I determined to see what was going on within the vessel and had a heavy glass front constructed. Repeating the experiments, I noticed that on opening the circuit an arc was formed about the size of a pea. The same arc in air would have been about 3in. long. After about a dozen breaks, however, the glass front was shattered, as though struck by a hammer. On further considering these results, it seemed to me that either the vessel had not been entirely filled with the oil or that the vessel was sufficiently elastic to allow the formation of the small arc noticed. It is not unlikely that both of these conjectures were true. However, the arc which actually formed was so insignificant that I felt encouraged and proceeded with my experiments, hoping to eventually produce results of practical value.

My first step was to overcome the pressure which accumulated, due to the formation of gases by the arc in the oil. I placed in connection with the containing vessel a small reservoir, having a direct pinhole communication with the main vessel, also a valve connection allowing oil to pass from the reservoir into the main vessel by gravity. The pinhole communication was placed in a dome directly over the switch terminals, so that the gases which formed would rise to the top of the dome and pass out into the reservoir, which latter was only partially filled with oil. The pressure being thereby released in the switch chamber, sufficient oil would flow through the valve communication from the reservoir to occupy the space which had been previously occupied by the gas. This plan proving satisfactory, I proceeded to determine the life of the switch as compared with a similar switch used for the same purpose in the open air. After making about 3,000 breaks I found that the oil had carbonised to such an extent that with the switch open there was a current leakage of several amperes. Various oils were subsequently tried, some of which proved better than others. Of these paraffin oil gave the best results.

I next tried glycerine and with it made 40,000 breaks. At the end of this test the switch terminals were found to be slightly scarred, the glycerine was black from carbonisation, but the current leakage was only a small fraction of an ampere on open circuit.

Having arrived at this point, I began to experience difficulty with the containing vessel, which now leaked badly in spite of the best fittings I could procure. To overcome this difficulty, I determined to increase the density of the liquid. It seemed to me that not only would a more dense liquid be less easily forced through the joints, which necessarily enter into the construction of the apparatus, but that it would also more effectually resist the formation of the arc. Satisfactory tests were made with a mixture of precipitated silica and glycerine.

Aside from the above results, the question "Can an electric circuit be opened without an arc?" is exceedingly interesting from theoretical as well as practical standpoints. In connection with electrical engineering problems of the day, it is one of no small importance.

TELEPHONE EXCHANGES AND THEIR WORKING.*

BY DANE SINCLAIR, MEMBER.

(Concluded from page 383.)

I have before now been accused of something like inconsistency in advising in favour of this system in some places and against it in others. In deciding upon any particular case the local circumstances have to be take into consideration, and after a careful study of the subject the decision I have arrived at is that, given a town where all, or nearly all, the subscribers' lines terminate in one exchange, there is no doubt that the call wire gives the most perfect service. For this reason we have introduced the call wire into Glasgow and nearly all the towns in Scotland. We are also introducing it into Manchester. It would, however, be absolutely unworkable in London. The full explanation of this would take more time than can be given to it in a paper of this kind; but, broadly, it may be said that in a great city like London, where there are a number of exchanges, and consequently the subscribers' lines terminate at a number of different centres, the call wire becomes unsuitable. Let us take an instance. Suppose a subscriber on our King's Cross exchange, whose office has been fitted with the call wire, wishes to communicate with a subscriber on Lime-street exchange, in the City, he presses his call-wire key and gives the listening operator the number of the subscriber he requires. The operator has then to do one of two things: she has either to cut herself off from the local call wire, in which case the main feature of the call wire—viz, continuous listening—is sacrificed, or to connect her telephone, as well as the call wire with its 50 subscribers, on to a call wire to the City. Other operators in the same exchange may have been asked by their subscribers for subscribers in the City, and may also have connected their call wires to the same City wire. In the event of a connection having to be made through two or three exchanges this trouble would be increased, and it would often be found that operating would be rendered impossible, owing to the large number of subscribers connected together all clamouring for their instructions to be taken first. The effect would be somewhat similar to that of a crowd of people attempting to rush out of a public building, on an alarm of fire, through a doorway too small to accommodate them; they simply get jammed in the doorway, with the unhappy result that they perish in the attempt. In the same way, the subscriber at King's Cross might stand at his instrument and perish before he succeeded in getting through to the subscriber in the City. With this explanation it will, I am sure, be apparent to anyone who thoroughly studies the matter how it is that the call wire may be successful at one centre where all, or nearly all, the subscribers' lines are grouped in one exchange, and be a complete

* Paper read before the Institution of Electrical Engineers.

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failure if introduced into an exchange system like that of London.

All things being considered, we find that the call wire gives more satisfaction than the indicator system, and it is perhaps to be regretted that it cannot be introduced under all circumstances. We had the indicator system with multiple boards at work for many years at Glasgow, and we changed to the call-wire system. Nine months after the introduction of the new system the subscribers were asked whether they preferred the call-wire or the indicator system previously in use, with the result that 95 per cent. of the subscribers were in favour of the new system; and it was this result that decided the question in favour of its introduction into Manchester. The call wire has been in use almost since the introduction of telephone exchanges, and here again I find that our friends on the other side of the Atlantic at a very early date saw the advantages to be derived from it, with both the make-and-break and the branching system. It is the latter system which is being introduced at Manchester. It so happens that at Manchester 90 per cent. of our subscribers have their lines terminating in the central exchange, and, consequently, it is a highly suitable place for the introduction of the call-wire system. We are now installing it there in connection with a new exchange which is being fitted with flat boards. The Manchester board is illustrated in the drawing Fig. 7. It will be seen that it differs somewhat in detail from that with self-restoring indicators which has been already described. The board will accommodate 7,200 subscribers' lines, and is now being fitted complete for 4,800, with the necessary trunk and junction wires in addition. The design of the framework has been so modified as to allow the operators to get nearer to the line jacks, which gives greater facilities for operating.

I may now refer to a few load curves (Figs. 8 and 9) I have prepared showing the number of calls passing through our busiest exchanges. At the top of these we find Liverpool, where the average number of calls per subscriber per day amounts to 18·6. The pressure of the work will, however, be better understood by noticing that at certain hours of the day the number of calls is very high.

An important part of an exchange system in a place like London is the proper arrangement and working of the junction wires between the different exchanges. I have found that the best way to arrange these is to have, in addition to the direct wires, a central junction-wire exchange, between which and every other exchange two or more wires are provided. It will be readily understood that in a system like that of London, where there are 37 exchanges, it would be impracticable to run from each new exchange opened in the suburbs direct wires to all the others. Therefore the central junction exchange becomes a necessity. It is obvious, however, that such a central exchange must introduce extra operating, and consequent delay, into the service, and, therefore, where we have as many as 60 or 70 messages per day between any two exchanges, we provide two direct junction wires. Beyond this, an additional junction wire is provided for each 40 messages per day. Taking the average duration of each call as three minutes, it will easily be seen that, to meet the maximum pressure at the busiest time of the day, so many junction wires have to be provided that the average time each is in use amounts to only two hours out of the 24.

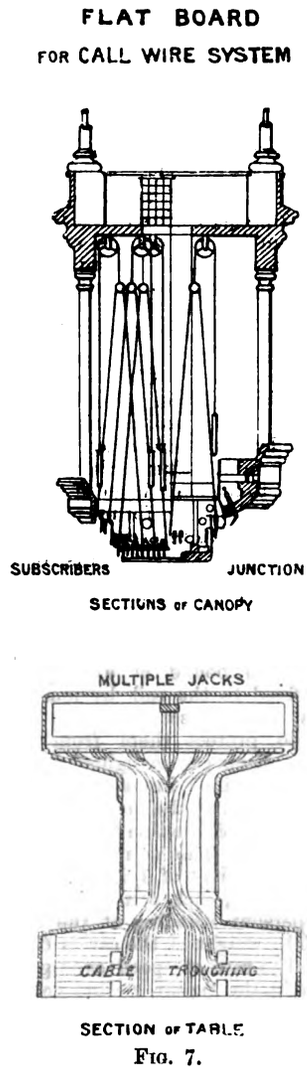

Fig. 7.

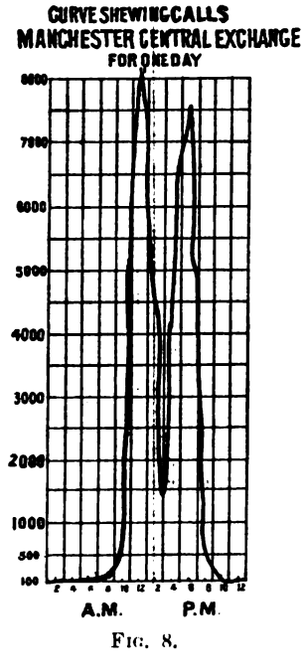

Fig. 8.

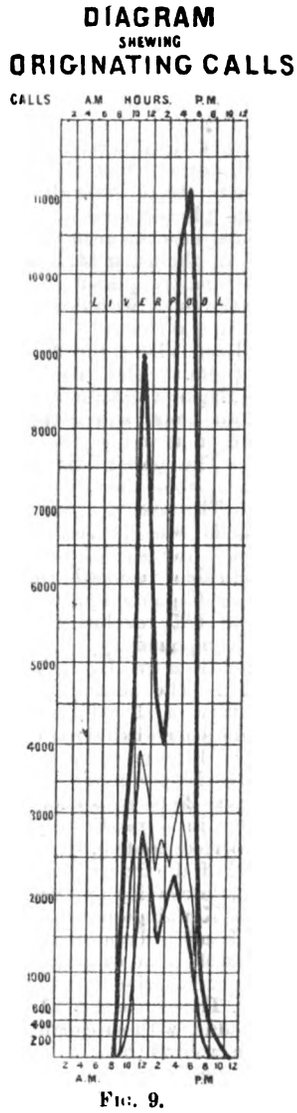

Fig. 9.

ELECTRIC TRACTION FOR TRAMWAYS.

The following is a copy of the report of the deputation appointed by the Belfast Corporation to visit various cities and towns where tramway traction by electricity is in practice, and report for the information of the Council:

The deputation inspected the various systems of mechanical traction as applied to tramways in the cities mentioned below, and they have much pleasure in recording the great courtesy and hospitality shown to them everywhere, and the marked willingness to impart information by the authorities and officials and by the officers of the different companies.

Dublin, Kingstown, and Bray.—This line is not yet opened for traffic, but some members of the deputation, also Sir Daniel Dixon and Sir William M'Cammond, were afforded an opportunity of inspecting it. A considerable portion of the line was formerly an ordinary horse one, but has been laid and arranged for overhead electrical traction. The experimental trip was very satisfactory. In this case the electricity is sent out at a

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high voltage and afterwards reduced by transformers at sub-stations.

Bristol.—The Bristol, St. George, and Kingswood tramways were opened in October last. The line commences at the western end of Old Market-street, where it joins two lines for horse cars, and extends for about four miles to Kingswood, the gradients being fairly easy for the most part, but for some portions have an incline of 1 in 15. The gauge of the line is the English railway gauge of 4ft. 8½in., same as the Belfast street tramways. In most of the route there is a double tramway track. The rails are of the ordinary flange type, weighing about 76lb. per yard. Two overhead copper trolley wires, 0 32in. in diameter, extend the whole length of the line and about 20ft. above street level. The wires supply the current to cars running in opposite directions. An armoured feeder is laid along the whole length of the line under the adjacent footway, immediately behind the kerbstone. The return current to the dynamo is obtained from the trolley wire through the car and along the rails, which are specially coupled together with copper attachments. In addition to the feeder, there is a three-strand insulated and armoured conductor laid the whole length of the line for telephonic and testing purposes. The trolley wires are supported at every 40 yards by ornamental cast-iron columns, with transverse arms, the trolley wires being suspended at the extremities of the arm. The public enter and leave the cars (as is generally the case on most lines) at special stopping places, marked upon the columns. The columns are sunk into the ground about 6ft., and surrounded with concrete. In the wider streets these columns, protected by cast-iron fenders, are placed in the centre way (5ft. 6in. in width) between the lines, with double projecting arms. Where the streets are not sufficiently wide for this arrangement, the columns are placed along the footways in the position of ordinary lamp-posts. The maximum speed on this and other lines in England sanctioned by the Board of Trade is eight miles an hour, and there is no difficulty in maintaining that rate, nor would there be of greatly exceeding it, if desired. The power station in Beaconsfield-road is about equidistant from the extreme ends of the electrical tramway lines. The greater part of the ground on which the station stands was previously occupied by the company's stables and car sheds, the buildings of which were, so far as practicable, utilised therefor. There are three dynamos, each yielding an output of 200 amperes, at 500 volts, when working at 650 revolutions per minute. The driving engines are of compound type, 135 h.p. at 380 revolutions. Steam is supplied from two Lancashire boilers, with a working pressure of 140lb. The accumulators at the central station consist of a battery of 55 cells, each cell having a capacity of 546 ampere-hours when discharged in six hours. The cars are lighted by electrical incandescent lamps from the main circuit. Each car is fitted with two motors, controllers, and other appliances, and will seat 20 persons inside and 24 on the roof. The cars were driven in a satisfactory manner, and under what appeared to be perfect control, the electric controller on the car regulating at will of the driver the speed or stoppage of the cars in ascending and descending gradients.

London.—The Kennington and Streatham Cable Tramway (worked by the London Tramways Company) commences near Kennington Church, and extends in a southerly direction to Streatham, the system being about 3½ miles in length, on double lines throughout. The centre slot is 1in. wide, the cable being laid in a concrete conduit with supporting trolleys about every 60ft. At each of these trolleys there is a small opening with covered plates to give access for repairs and oiling. The rope is of steel wire, working at each terminus over a wheel of about 10ft. diameter. The power station is situated about 2½ miles south of Kennington Church, and is driven by two powerful compound engines, the steam being supplied by a series of Babcock and Wilcox boilers. Coke is the fuel used. An elaborate system of underground subways is required to conduct the driving ropes to their working position under the tramway line. The cars are of the usual type, and are run not only over the cable system, but over other lines of the London Tramway Company worked by horse traction. The horses bring the cars to the Kennington Church terminus, whence they are drawn by separate driving or "dummy" cars, of which about 40 are in use. The grip on the cable seems to be made gently at first, to avoid shock, necessarily causing a slipping and friction on the cable. The maximum speed allowed by the Board of Trade is eight miles an hour, and the average running is about six miles an hour.

Havre.—The electrical tramways in Havre are about eight miles in length, running through the central as well as the suburban portions of the town. The lines are for the most part double, although in some of the narrower streets, and in the suburban line to St. Addresse, a single line is adopted. In the wider streets there are placed central iron columns with projecting arms in a similar manner to those at Bristol. For the greater portion of the lines iron columns (without arms) are placed opposite each other in the footways with connecting cross wires, from which are suspended the overhead trolley wire, and in a few places where it is inconvenient to place columns the cross wires are stretched from building to building and attached thereto by ornamental rosettes. The deputation were informed that leave to make these attachments to buildings was easily obtained from the owners and occupiers of property. The poles for supporting the overhead trolley wire are placed from 131ft. to 164ft. apart. The main feeder is laid at the side of the line in earthenware pipes. Two wires are placed over the trolley wire in some portions of the line, which serve not only for telephonic communication, but also to prevent the contact of any overhead telephone wires accidentally falling upon the trolley wire. The general arrangements as to motors, controllers, and trolley are similar to those at Bristol. There are about 40 motorcars at present in use. The gradients through a considerable portion of the town are easy, but in the higher districts they reach an inclination of about 1 in 17, and do not cause any inconvenience in traction. The power for working the line is supplied by a company distinct from the tramway company, and which also supplies the lighting for the city and harbour. The greatest distance of any portion of the tramway lines from the power station is about 2½ miles. The maximum given from the dynamo is 500 volts. They have no accumulators in the power station.

Paris.—There are three different methods of mechanical traction for tramways here—(1) cars worked by compressed air; (2) the Serpollet steam trams; (3) electric cars run by accumulators. Each of these systems appear to be more or less cumbrous and unsightly, especially in the case of the compressed-air car, which weighs no less than 22 tons, exclusive of the trailer car. The compressed air and accumulator cars are charged at each terminus, the former being worked at an initial pressure of 50 atmospheres, with reducing valves to diminish the pressure at will.

Brussels.—The Brussels tramways were installed by the Union Electrical Company of Berlin. The lines supplied electrically are those from north to south by the Circular Boulevard and the branch lines from Brussels to Uccle. The cars are driven from two trolley wires, divided into sections of about 1,640ft., each section being connected at its extremities to the feeder by cables rising inside the columns. The cable is placed in the soil without any other protection than a layer of bricks laid dry in order to denote its presence during future works along the line. These cables are supplied with interrupters, which permit any one section to become out of circuit in case of necessity. All along the boulevards the trolley wires are suspended to ornamental brackets, supported by tubular columns. In the streets the wire is carried by steel cross wires fixed to the façade of adjacent buildings. In order to facilitate the return of the current, the rails are bound at each joint by two lengths of copper wire, fixed to the rail by means of rivets in mild steel. Strips of creosoted wood are placed over the trolley wires to protect them from the fall of overhead telephone wires. Each car is lighted by five incandescent lamps of 100 volts, obtained immediately between the trolley and the rails. The length of the boulevard line is about three miles (double width), and of the line to Uccle two and a half miles (mostly single line). The minimum radius of the curves is about 82ft., with a gradient of 1 in 15. The rolling-stock embraces 26 covered cars, each containing seats for 16 persons and room for 20 persons standing at the ends. Each car carries two motors. The weight of the car is 6·3 tons, and nearly 9 tons when full. The rate of speed averages 7½ miles an hour. The machinery in the power station comprises five compound non-condensing engines and three Babcock and Wilcox boilers. The five dynamos are each of 100 kilowatts (500 volts, 200 amperes) of normal duty. The switchboard contains automatic circuit-breakers to break the circuit when the load on the dynamos exceeds the maximum. There are no accumulators at the power station. The service of the cars occurs at very close intervals. Another electrical tramway from the city to the Petite Espinette is vested in another company. The gauge of this tramway is 3ft. 2in. The rails weigh 46·3lb. per metre, with plate riveted on rail to form the groove, bringing the weight up to 68·3lb. per metre. The service on this line is every 10 minutes in summer and 15 in winter. There is one curve on this line of 115ft. radius on a sharp incline, but there is no difficulty in traversing it. The power station is practically on the same lines as that of the last-mentioned line. The most distant part of this tramway is about 8½ miles from the power station. In several portions of the line the wires are carried by means of transverse wires, attached to the buildings by means of ornamental rosettes, but in the more distant portions of the line, which traverse what may be termed a country road, these cross wires are at present attached to unsightly wooden poles at the sides of the road, but are now being replaced by light ornamental iron ones.

Hanover.—The system adopted here is that of the overhead wires, except in the more central portions of the city, where the cars cease taking power from the trolley line, and work from accumulators placed under the seats. These accumulators are charged from the trolley wire whilst the cars are running with that method of contact. Although there are only eight such

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cars running now, there will be 60 in three months, as the present horse tramways are to be supplanted by them. The accumulators give an extra load to the cars of about 1¼ tons. In place of the ordinary trolley attachment the Siemens rectangle trolley frame is used, for which is claimed, amongst other advantages, the reduction of the necessity for cross wires to stay the trolley wire going round a curve. The columns and brackets for supporting the trolley wires in Hanover are richly decorated, but are unnecessarily heavy in design, and too close together. The cars have one motor, and the usual controller at each end.

Hamburg.—The tramways of this city are electrical, on the overhead system, with a street mileage of 49·7 miles, containing about 87 miles of tramways track. There are about 300 electric cars at present running, and there will be shortly about 400. Each car without passengers weighs about six tons, and contains only one motor. The steepest gradient is 1 in 20. Electric cars traverse all the principal streets of the city, some of which are comparatively narrow. Cross wires with rosettes are freely used, and where difficulty occurs in placing the latter long lengths of the trolley wires are successfully kept in position by single-wire slanting stays. There appears to have been no difficulty in obtaining the consent of the owners to the placing of the rosettes on the adjacent buildings. The electricity to run the tramways is supplied from two powerful installations vested in the municipality in separate portions of the city. These stations also supply the power for public electric lighting. One of these stations, in the neighbourhood of the Binnen-Alster, contains powerful vertical triple-expansion engines driving directly on the dynamos, with accumulators capable of storing 12,000 ampere-hours at 110 volts. These accumulators provide the supply from midnight to 1 p.m. next day. The newer station in another district of the city contains three triple-expansion engines of marine type of 1,000 h.p. each. There are five boilers to supply these engines, and five more are being erected. The feeder to supply the trolley wire is placed in the carriageway near the footway. The switch arrangements on the ground floor of the engine-house regulate the supply to the tramways, and those on the upper floor for public lighting. Current for lighting purposes is also supplied, being produced at high tension (2,500 volts, with alternators) in this station and transformed to low tension by district or house transformers. The current from the Binnen-Alster station is sent out for lighting purposes only on low tension (240 volts).

Berlin.—About 12½ miles of electric tramways are about to be constructed in Berlin, for the most part overhead, the rest being on the conduit system. The drainage of the conduit will be into the sewers, which are considerably above the level of the River Spree. A power station, belonging to a separate company, will supply power for the tramways. The underground conduit will be 2ft. deep. It has been arranged by the municipal authorities that at least 10 per cent. of the tramways will be on the underground system.

Dresden.—Besides the electrical overhead tramways in Dresden, a tramway has been running for two years by gas traction. The charging of the cars with gas takes place at one of the termini, and occupies about two minutes, the gas being equal to seven atmospheres. This charge lasts for about one hour, at the end of which there are still two atmospheres' pressures, assuming the cars to have gone at the rate of about eight miles per hour. The actual speed of the cars, however, appeared to be at the rate of about six miles per hour. The cars each weigh about 3·8 tons (without passengers), and they are eight in number. The objectionable features of these cars seem to be: (1) unsteadiness of motion; (2) knocking heard from the engine when car is stopped; (3) smell of the exhaust from the gas-engine; (4) the waste of running engine during stoppages.

Vienna.—A small electric railway (the second ever made in Europe), about three miles in length, is working in one of the suburbs of the city; but up to the present overhead wires have not been introduced within the central portion of the city bounded by the "Ringstrasse." There is, however, a new length of electrical tramway commenced outside this portion. In the suburbs two electric accumulator cars ran for some time alternately with steam trams, but are now off. It is expected, however, that they will be placed on again shortly with improved accumulators.

Budapest.—The electric tramways in this city are, with one exception, entirely on the conduit system. The invert of the conduit is about 22½in. from the surface of the rails. The bed or under side of the conduit is about 4in. deeper. Access can be had to the conduit about every 109·3 yards for the purpose of snow cleansing. The conduit or channel is solidly constructed. At intervals of about 4ft. there are placed cast-iron frames, each weighing about 1¼cwt., having in the centre a hollow of the exact shape of the conduit, which is built up in concrete from frame to frame. To these frames are fastened two girder rails, the distance apart being 1½in., forming the slot through which the collector works. The width of the slot, however, increases with wear, and in some places is as much as 1⅞in. wide. In the older portions of the line contact is made with two lengths of angle iron fixed to insulators, one on each side of the iron frame; but a new and improved insulator and contact iron has been adopted for the new portions. One length of iron conveys the electrical energy from the works, and the other forms the return current. Every insulator in the conduit can be examined from the surface by the opening of a small plate. There appears to be little or no difficulty in draining the conduit in Budapest, as the lowest streets are a very considerable distance above the level of the Danube. The power station for driving the tramway system and for lighting the city is furnished with compound condensing engines, driving the dynamos direct. The station contains four engines of 200 h.p. each and three new engines of 600 h.p. each. The tramway supply is sent out at 300 volts. The supply for two district lighting stations is sent out at 3,000 volts, with transformers giving out 110 volts. The boilers for supplying the engines each have 2,906 square feet heating surface. There were 100 cars running last year, but the number has been increased to 150. A new electrical tramway in tunnel is approaching completion from the central portion of the city to the exhibition, to be opened this year. The contact in this case is obtained from an overhead iron rail in the tunnel. A suburban electrical tramway on the overhead system is worked on the route leading to the city cemetery.

Birmingham.—In Birmingham, besides the horse cars, there are steam tramways worked by accumulators. The permanent way is vested in the Birmingham Corporation, and repaired by them at the companies' expense. The gauge throughout is 3ft. 6in., and part of the line originally made to the English railway gauge was converted to this narrow width. The steam tramways have a five minutes' service, the cable trams about a two and a half minutes' service, and the accumulator cars have about a fifteen minutes' service.

General.—After a minute examination of the various systems of mechanical traction obtaining in the cities they have visited, and a careful study of their adaptability to the particular physical and other conditions relating to Belfast, your deputation have come to the conclusion that electrical traction, under certain conditions, is best suited to the wants of the public and requirements of the city. They believe that any unprejudiced person, after having visited the leading European cities, could come to no other conclusion. The objectionable features in connection with steam or gas as a motive power are too great to allow of their being recommended in any known form. The difficulties that would be encountered in introducing an underground conduit system to the lower portions of Belfast, having regard to the position of sewers, covered river courses, gas and water mains, the relation of street surfaces to high-tide level, and the necessarily wide groove required in the rails, are so great that the deputation cannot recommend its adoption. The most extensive conduit system is at Budapest, and the engineer there stated that, whilst it generally worked satisfactorily, there had been interruptions of the traffic owing to the flooding of the conduits, although there was no difficulty from an engineering point of view in regard to drainage. Although your deputation feel that very fair results have been evidenced in connection with the running of cable tramways where traffic is heavy, their mechanical features are such as to render necessary extreme accuracy in time of the tramway service problematical, and they, therefore, could not recommend their adoption. After having carefully weighed the question as to certain central portions of the city being dealt with by means of accumulator cars, they have arrived at the conclusion that to introduce such a system as separately working the central portions of the city, or even as in Hanover, working the cars interchangeably by accumulators and the trolley wire, would not give public satisfaction. Having regard, therefore, to the fact that all practical objections to the overhead system have been surmounted, and that any exceptions thereto from an æsthetical point of view have been reduced to an almost infinitesimal quantity in the best examples of the overhead system, the deputation feel perfectly confident that they are doing the right thing in recommending that system, with certain stipulations, as the best and most suited to the public interest. They recommended also that any proposition made for the conversion of the Belfast tramways on these lines should be subject to the following conditions: (1) All columns, feeders, pipes, wires, brackets, and rosettes shall be in such positions and of such pattern, material, and strength as may be approved of by the Corporation or the city surveyor, and such of them as require shall be painted at least once in every year with good oil paint of colours likewise approved of. (2) No column, bracket, or electrical plant shall be used for the display of advertisements without the consent of the Corporation. (3) Where centre columns are erected they shall be protected with raised fenders to be approved of by the Corporation or their surveyor, and the width of the centre way between the two tramway tracks shall be carefully considered. (4) If any column, bracket, or overhead wire after it has been erected shall, in the opinion of the Corporation or their surveyor, be an obstruction to the traffic, the company shall remove it or alter the

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position thereof in such manner as the Corporation or their surveyor shall approve. (5) The company shall, in executing any work, take such precautions and do such acts as the Corporation may require for preventing injury to any sewer, pipe, electric wire, or conduit, gas-pipe, lamp-post, or other property belonging to the Corporation or other public authority. (6) Existing paving stones, concrete foundations for same, macadam and its stone or other foundation, where used by the company, shall be paid for by the company to the Corporation, the value thereof being assessed by their surveyor. (7) The centre way, tramway tracks, and 2ft. on each side of same shall be kept in repair by the company, same as the present tramways. (8) All manholes and ventilating shafts and their covers on the site of the new tramway paving shall be altered by the company, or at their cost, so that the covers may be outside the tramway paving, in order to keep the tramway track open at all times, the shafts being altered to suit the new arrangements, and any interference with sewers, drains, gas-pipes, water-pipes, electric mains, and other subterranean works, whether vested in the Corporation or not, that may be disturbed or altered by reason of the alteration or reconstruction of the tramways, shall be executed by the company to the satisfaction of the surveyor, or, failing the work being done to his satisfaction, the city surveyor, after giving one week's notice to the company in writing, may, on behalf of the Corporation, execute such works as are necessary by reason of such interference, and the cost thereof shall be chargeable to and paid by the company. (9) Special arrangements, approved of by the Corporation or their surveyor, shall be made to carry the wires, feeders, and other appliances along the various bridges over the River Lagan, its tributaries, and the various railways. (10) Any officer of the Corporation or member of the fire brigade may at any time, if deemed by him necessary for the public safety, or in case of fire, remove any overhead wire. (11) The Corporation shall be empowered to purchase the electric plant of the company at the end of the present term of 14 years at its then value without any allowance for compulsory purchase, goodwill, or other consideration. (12) The tramway company shall pay the cost of altering the fire-escapes rendered desirable on account of the introduction of overhead wires and stays in connection with the electrical lines. (13) The tramway company shall afford facilities and allow the Corporation to use their poles for lighting purposes, and make their poles suitable for that purpose if desired. The deputation could not fail to observe in the various cities they visited that along what may be termed the suburban electrical tramway routes there is in nearly every case a rapid development of residential and other property, and a consequent enhancement of the value of the adjacent lands. They also remarked the facility with which trailer cars are attached to the motorcars to accommodate additional passengers when required, but more than one such car should not be permitted to be so attached. The deputation were continually struck with the fact that electrical traction can be worked by comparatively unskilled labour, with the greatest precision and delicacy of movement, and under the most perfect control. The deputation were satisfied of this by practical demonstrations, and the facility by which steep gradients can be mounted and descended. In Havre and Brussels they were driven at great speed, and, whilst doing so, the cars were quickly stopped, and even reversed without inconvenience. Their strong impression is that the travelling public are perfectly satisfied and even delighted with this mode of transit. This is evidenced in a marked manner by the quickness of the service and the manner in which the cars are filled.

INSTITUTION OF CIVIL ENGINEERS

PROPOSED ALTERATION OF BY-LAWS.

In accordance with the resolution passed at the special general meeting held on February 6, a petition was duly presented to her Majesty for a supplemental charter to enable the votes of members not actually present at meetings to be taken into account in the election of the council, and to authorise the enlargement of the council, and the appointment of four past-presidents as extra members of the council. The charter has now been granted, and this will necessitate an immediate alteration of certain sections of the by-laws, which will have to be sanctioned at a special general meeting of corporate members. This meeting has been called for Wednesday, April 15, at 3 30 p.m., when the new by-laws given below will be discussed. In addition to the above matters, it is proposed to consider the advisability of commencing the session one week earlier and terminating it on the last Tuesday in April, and, if such alteration be approved at the general meeting, to modify the by-laws accordingly. The alterations to the existing by-laws are as follows:

Section VI shall be intituled "Constitution of Council," in lieu of the present title.

The following shall be substituted for Regulation 1, and the first clause of Regulation 2 and Regulation 4 of Section VI.: (1) The number of the council shall be such as the council in any year may fix for the ensuing year, provided that such number shall not be less than 23 or more than 31 inclusive in both cases of the president and vice-presidents, but exclusive of such of the past-presidents, if any, as may be appointed by the council. The president, the four vice-presidents, and other members of the council (exclusive of past-presidents, to be appointed by the council) shall be elected annually, and the council, when elected for the year, may appoint any number of past-presidents, not exceeding four, to be members of the council for the same year. (2) At an ordinary meeting at least four weeks before the annual general meeting the council shall present a list of persons whom they nominate as suitable for the offices of president, vice-presidents, and other members of the council for the ensuing year, exclusive of past-presidents to be appointed by the council when elected. The list shall include the names of not less than seven corporate members who have not served on the council during the current or the preceding year, and the number of names in all shall be at least two in excess of the number of the council to be elected. The list so presented shall be the balloting list for the annual election on the last Tuesday in May, unless that Tuesday shall be Whitsun Tuesday, in which case the annual election shall take place on the first Tuesday in June. (4) At the ordinary meeting next before the annual general meeting the members shall choose two or more persons as scrutineers for the purposes of the ballot. The balloting list shall immediately after the ordinary meeting at which it has been presented by the council be issued to all members in the United Kingdom, and to any other member residing elsewhere, who may, in writing, request to have the list forwarded to him, and shall be returned to the secretary, at least three days before the annual general meeting in a closed envelope. The scrutineers shall open the envelopes and count the votes and report the result at the annual general meeting. Any balloting list on which a member has voted for a number either more or less than one person as president, four persons as vice-presidents, and the prescribed number of persons as other elected members of council, shall be rejected by the scrutineers.

That the following consequential alterations be made in the by-laws and regulations—that is to say: In Section II., Regulation 8, the words "and other members of the council to be elected or nominated under the by-laws," shall be substituted for the words "and 15 other members of council, being 20 persons."

Section IX. shall be intituled "Proceedings of Council," in lieu of the present title, and Regulation 1 of the same section shall be erased.

That the following further alteration be made in the by-laws: In Section III., Regulation 11, the words "In case the expulsion of any member, associate, or honorary member shall be judged expedient," shall be omitted and the following words shall be substituted: "The council shall have the right, by a majority of two-thirds of those present at a meeting of the council, to expel from the institution any member or associate who may be convicted, by a competent tribunal, of felony, embezzlement, larceny, or misdemeanour, or other offence which, in the opinion of the council, renders him unfit to be a member; and in case the expulsion of any member or associate shall be judged expedient on any ground whatever."

COMPANIES' MEETINGS AND REPORTS.

WILLANS AND ROBINSON, LIMITED.

The fourth half-yearly meeting of this Company was held at the Cannon-street Hotel on Wednesday, April 8, the chair being taken by Mr. Mark Robinson, M.I.C.E. There were also present Sir Gilbert A. Clayton-East, Bart; Captain H. Riall Sankey, R.E. (retired), M.I.C.E., etc.

The report and balance-sheet, which were published in our issue of April 3, were taken as read.

The **Chairman**, in moving the adoption of the report, said: Gentlemen, again the directors are able to address you in terms of congratulation. When the report was written we could only say that in less than three months the orders had reached 22,200 h.p.; we can now say that in three months they actually reached 24,400, or some 28 per cent. more than in the whole 12 months of 1893, itself the record year up to that time. Omitting the Thames Ditton freehold, which follows a practically uniform rule, the value of our plant and machinery and patents at the beginning of 1895, plus the additions to them during that year, was £60 600, and from this sum we wrote off no less than £6,703, or between 11 and 12 per cent. on the total. Yet our plant and machinery are kept in first class condition out of revenue. It has been the steady object of the directors for some years past to promote a demand for the Willans engine in much larger sizes, so soon, that is as we may be in a position to supply them. We are glad to say that among the recent orders is one for four engines of 1,100 h.p. each, to be made, of course, at Rugby. We have an engine of 750 h.p. on order for electric lighting, for one of our municipal bodies, and two of 600 h.p. each for another. An engine of 750 h.p. and another of 700 h.p. are on order for driving mills on the Continent, while nearly 40 engines are on order of sizes from 300 h.p. up to 500 h.p. In fact, the average size of the engines ordered in the first quarter of 1896 was not less than 263 h.p. The development of the really large engine waits, of course, the completion of the new works. We had hoped to be almost commencing work at Rugby by now; we shall not do so until the year is far gone. We have had to modify

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the plans, in the sense of enlarging them, while the work was in progress, and to commence additional shops. Of the cost of the new works, and of the plant required for them, it is still early to speak with exactness. If no substantial additions become necessary we may expect the cost of land, buildings, fencing, tramways, drains, levelling, etc., to be about £50,000, in addition to £9,800 which had been spent up to the end of 1895. The plant required for the buildings as now planned, including, of course, not only machine tools, but such plant as engines and boilers, electric lighting and power plant, shafting and pulleys, cranes and overhead travellers rolling-stock and fire appliances, will probably cost us fully £30,000 beyond what had been spent up to December last, and including an allowance for various things which it is not desired to order until we are actually at work at Rugby. The two sums added together make £80,000 still to be spent, but it is evidently necessary to allow a margin beyond this. The existing company paid the old company £148,500 for its business, and the present paid-up capital, £225,000, exceeds this sum by £76 500. We have to account for not only £76,500, but also for £13,269, which is the amount we have reserved out of our earnings during the two years to cover the assumed depreciation of our premises, plant, and patents, but which, nevertheless, has remained in the business, and has been at our disposal to spend. We have also to account for £1,130 which we have received under the system of workmen's bonds We have to account, therefore, in all, for £90,899. Of this £33,476 was absorbed, as was intended, in paying off the mortgage debt, the debenture debt, and a banker's loan, transferred from the old company, and a half-year's dividend to the old shareholders. The present balance-sheet shows that at the end of December we had in hand, in cash or investments (not including the reserve fund investments), the sum of £15,823 over and above £11,832 profit carried forward for distribution to shareholders or to reserve. We also spent during the two years £29,235 upon additions to premises, plant, and patents. The three amounts together come to £79,543, which leaves us out of the total of £90,899 a balance of £12,365, which, subject to some minor corrections, is the increased amount which has been absorbed into the floating capital of the business during the two years of fast-growing work. It need not be said that as between the floating capital which with difficulty sufficed us in December, 1893, and that likely to be required by the business we may expect to develop within the next two years at Rugby, a greater difference than £12,000 will be necessary. We have to provide not only for a great increase in the engine business, but we hope for a wholly new as well as large business in Niclausse boilers. The directors feel that any loss of interest caused by borrowing a few thousand pounds more than may be immediately required, is unimportant in comparison with the advantage which attaches to the command of ample funds. The directors are not at present disposed to recommend an issue of more than £75,000 to form part of an issue which may be increased later to £100,000, subject to an undertaking, to form one of the conditions of the issue, that the total issue shall at no time exceed one-third of the paid-up capital, whatever the latter may be, and shall never, of course, exceed £100,000 The authority to borrow up to £112,500 in all, proposed in the resolution, is necessary in order to give power to the directors to obtain small loans (as from the Company's bankers) in the ordinary course of business. There is one point upon which the directors are very willing to pledge themselves—namely, that no money shall be borrowed without the institution of a sinking fund for its complete repayment within the agreed term of years. Allusion has been made to the Niclausse boiler. The delay in making it upon a large scale is not wholly an evil: it has enabled us to test it by extended use in various places before pressing it upon public acceptance. It has borne all tests most admirably. One electric lighting company which lately had two boilers from us has ordered three more, and quite enough are on order elsewhere to afford a most thorough trial. Arrangements have been made with the Admiralty for the manufacture of a set of Niclausse boilers for H.M S "Seagull," under royalty, by Messrs. Humphrys, Tennant, and Co., and the same eminent firm are also making other Niclausse boilers under license from us. So far as we can foresee, this business promises very well indeed.

Mr. Willcox seconded the motion, and the report was unanimously adopted.

The **Chairman** proposed that a dividend at the rate of 6 per cent. per annum on the preference shares and 7 per cent. per annum on the ordinary shares be declared.

Mr. G. W. Ande son seconded, and the motion was carried.

Sir Gilbert Clayton-East moved, "That the directors be, and they are hereby, authorised to borrow for the purposes of the Company, any sum or sums of money not exceeding £112,500 to bear interest at such rate, to be secured in such manner, and to be issued on such terms, as the directors may determine."

This was seconded by **Mr. Anderson**, and carried.

The auditors were elected, and a vote of thanks to the chairman having been passed, the meeting terminated.

PONTYPOOL ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

The annual general meeting of the shareholders of this Company has been held at Pontypool, Mr. W. Pegler presiding. The directors' report stated that since the last report the Company had obtained a provisional order giving them an extended lease of their undertaking for a period of 42 years, but had to consent to clauses being inserted therein giving the local authority liberty to purchase the undertaking at the end of each seven years of the term, the purchase-money to be ascertained by two valuers, who, in arriving at the valuation, are to take into consideration the amount of the capital expended by the undertakers, and, in addition, in respect of the goodwill, a sum equal to the total net profits of the undertaking for the five years immediately preceding their purchase. Since the last report several new customers had been added to the Company's mains, there being 54 different connections attached to the Company's system, and there are others now being made, and the directors consider that the prospects of the Company are very promising. From the accompanying accounts it appears that the working of the station for the year ending December 31, after having carried a sum of £67. 10s. to the renewal account, has resulted in a net profit, which, with the balance carried forward from last year, amounts to £230. 4s. 3d. Of this the directors recommend that a sum of £50 be carried to the reserve fund, and that a dividend of £3 per cent. should be declared on the share capital of the Company, and that the remainder be carried forward to next year's account.

The report was adopted, on the proposition of **Mr. Pitten**, and a dividend at the rate of 3 per cent. per annum was declared.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Prague (Austria).—Tenders are wanted by June 1 for an electric lighting central station for the city of Prague. Application should be made to the Stadrath, Prague.

Luttre (Belgium). - Tenders will be received until April 15 for the construction of an electric generating station at the Luttre Railway Station. Particulars are obtainable at the Bourse, Brussels.

Elberfeld.—Tenders are wanted by April 20 for the supply of four engines and dynamos and 174 lampe, conductors, etc., for the Prussian State Railways. Address, die Königliche Eisenbahn-Direktion, Elberfeld, Germany.

Bucharest.—The Postal and Telegraphic Administration of the Roumanian Government desires tenders by April 18 for the supply of 60,000 porcelain insulators (three sizes) and 10,000 porcelain shackles, for the State telegraphs.

Harrogate.—The Corporation want tenders by April 13 for steel roofs, girders, etc., for the electricity generating station on the Corporation farm, near Harrogate. Particulars may be obtained from Mr. Samuel Stead, borough surveyor.

Vienna.—Tenders are wanted by April 15 for the supply of fastenings and tubes for an extension of the Vienna telephonic system. Particulars can be obtained from the Austrian Administration of Posts and Telegraphs, Section 13, Vienna.

Bedford.—Tenders are wanted for the supply of vulcanised rubber cables for the Corporation's electric lighting. Particulars can be obtained on application to the town clerk's office, Town Hall, Bedford, and tenders must be sent in by the 21st inst.

Chateau Chinon (France).—Tenders are wanted by April 19 for engineering and electrical work in connection with waterworks at Château Chinon, in the department of the Nièvre. The estimate is 43,750fr. (about £1,750), and particulars are obtainable at the Mairie, Château Chinon.

Blackpool.—Tenders are wanted by April 11 for all work necessary for the provision of foundations for one engine and a condenser at the Corporation's electricity works. Particulars may be obtained at the office of Mr. John Hesketh, borough electrical engineer, West Caroline-street, Blackpool.

Lisbon.—Tenders are wanted by the Royal Portuguese Railway Company for the supply of articles and material necessary for the upkeep of their electric lighting. Tenders must be sent to the chief engineer, at the company's stores at Santa Apolonia Station, Lisbon, by May 6, and particulars can be obtained there, or at the company's Paris offices, Rue de Châteaudun 28.

Bedford.—Tenders are wanted by the Bedford Urban Sanitary Authority for the construction in various positions in the borough of five underground sub-stations. Plans and specification may be seen at the Engineer's Office, Electricity Works, Bedford, and sealed tenders, endorsed "Sub-Stations," must be delivered at the office of Mr. T. S Porter, clerk, Town Hall, by 21st inst.

Arlon (Belgium).—Tenders are wanted by April 13 for the reconstruction of the locomotive, wagon, and electric lighting shops at the railway station. Particulars at le bureau des Chefs de Service, Arlon, rue de la Station, 36. Also by April 16 for the construction of a reservoir and alterations in the water supply and electric lighting at the Marbehan Station. Address as before.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grange town, Yorkshire, to whom the plans, etc., must be sent by May 1.

Edinburgh —Tenders are required by April 11 for the wiring of the police cells, Police-chambers, for the Lord Provost and Magistrates and Council. Specification, forms of tender, and plans of the building can be obtained at the office of the resident electrical engineer, 5, Dewar-place, Edinburgh, on deposit of £2. 2s., which deposit will be returned on receipt of a bona fide tender. Tenders must be sent to Mr. Thomas Hunter, W.S., town clerk, by 10 a.m. on 11th inst.

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Lima (Peru).—Tenders for the electric lighting of the city of Lima will be received up to June 1 next at the Peruvian Legation, 13, Comeragh-road, West Kensington, W., where applicants can obtain a memorandum explaining the local conditions. The tenders will be opened and considered by the Municipality of Lima, which reserves to itself the right of selecting that which is most approved or rejecting all if it thinks fit.

Rathmines and Rathgar.—The Town Commissioners want tenders by April 20 for the electric lighting of the new town hall (about 250 lights, with engine and dynamo), and also for telephones and electric bells Plans and specifications can be seen at the office of the secretary to the Commissioners, Town Hall, Rathmines, Ireland, or copies will be supplied on payment of 10s., and tenders, in sealed covers, endorsed "Tenders for Electric Lighting," must be sent to the above address by April 20 at 10 a.m

Derby.—The Electric Lighting Committee invite tenders for the supply and laying of low-tension cables and junction boxes in the borough. Plans may be seen on application to Mr. J. E. Stewart, engineer, Electric Lighting Station, Derby, from whom a printed form of specification, form of tender, and schedule of prices may be obtained on deposit of £2. 2s. (to be returned on receipt of a bona fide tender). Tenders on the prescribed form must be delivered with the specification attached. enclosed in a sealed envelope, endorsed "Electric Lighting -Tender for Cable," addressed to Mr. H. F. Gadsby, town clerk, Town Hall, Derby, by 12 noon on April 13.

Antrim.--The Commissioners for the Control of Lunatic Asylums will receive sealed tenders up to 10 a m. on May 1 for the supply and erection of an electrical installation at County Antrim Lunatic Asylum. The tender should be sent in a sealed envelope, endorsed outside "Tender for Electric Lighting, County Antrim Asylum," and addressed to the secretary, Board of Control, Custom House, Dublin. and should be accompanied by a separate sealed envelope, similarly addressed and endorsed, containing the detailed estimate. Forms of tenders, and copy of specification, which has been prepared by Mr. J. H. Greenhill, M I E E., will be issued on application to the office of the Board of Control of Lunatic Asylums, Dublin, on deposit of £3, which will be returned to all persons who have sent in bona fide tenders. Plans can be seen at the office of the architect, Mr. John Lanyon, Northern Bank-chambers, Royal-avenue, Belfast.

London —The Shoreditch Vestry require tenders for: (Section A) high-speed engines, electric generators, switchboards, instruments, and street lamps; (Section C) motor transformers and starting switches; (Section D) accumulator battery and stands. All to be delivered and erected complete at the Vestry's electric generating station, Coronet-street, Shoreditch or in sub stations within the parish. Specifications, with forms of tender, can be obtained from Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of £3. 3s., which sum will be returned on receipt of a bona fide tender. Contractors are at liberty to tender for any one of the separate sections or for the whole of the contract, but the Vestry will not consider any tender for a portion only of any of the separate sections. Contractors whose tenders are accepted shall enter into a formal agreement, under seal, with sufficient sureties, for the fulfilment of their respective contracts. Trade union rate of wages and hours to be observed. Sealed tenders, endorsed "Tenders for Contract No. 4," to be sent by 4 p.m. on April 14 to Mr. H. Mansfield Robinson, vestry clerk, Town Hall, Old-street, E.C.

RESULTS OF TENDERS.

St. Pancras (London).—The Vestry have accepted the tender of Messrs. Crompton and Co., Queen Victoria-street, E.C., at £6,456. 17s. 10d., for spare plant at the King's-road electric lighting station.

Halle-a.-S. (Germany).—The lowest tender for the supply of telegraph poles to the Prussian State Railways on March 24 was that of the Berliner Holz-Comptoir, Charlottenburg, at 2·40 marks, 3·15 marks, and 4·20 marks per pole for lengths of 7 metres, 8·5 metres and 10 metres respectively delivered at Crampe or Driesen.

Berlin.—The lowest tender for the supply of 5,000 porcelain insulators to the Prussian State Railways at Berlin on March 25 was that of the Gebr. Rheinstrom at 34½pfg. each, the prices offered varying according to pattern and place of delivery. The lowest tender for 15,400 kilogrammes of 4mm. galvanised iron wire was that of the Westfa. Draht-Industrie, Hamm-i-W., at 13·95 marks per 100 kilogrammes.

BUSINESS NOTES.

Great Northern Telegraph Company.—For the month of March the receipts were £22,400

Western and Brazilian Telegraph Company.—The gross receipts for the week ending April 3 were £2,180.

Bedford.—The Post Office have now completed their local telephone line from London through St Albans and Luton to Bedford.

Parliamentary.—In the House of Lords on March 31 Royal assent was given to the Electric Lighting Provisional Order (Notting Hill, etc.) Act.

Rouen (France).—The National and Colonial Exhibition will be opened on the 16th of next month, and will contain a section devoted to electric lighting.

Bury St. Edmunds.—The Electric Lighting Committee will recommend the Town Council to adopt an alternating-current system with plant similar to that at Bedford.

Dundee.—A sub-committee of the Town Council having considered the charges made for electric lighting, have reported that they see no cause to alter the charges in the meantime.

Hawick (Roxburgh) —The District Committee have decided to extend telegraphic facilities to Roberton, provided satisfactory arrangements can be made with the Post Office authorities.

Paddington (London).—The Vestry have decided to take steps to obtain a reduction of the price of current per Board of Trade unit from the Metropolitan Electric Supply Company, and with power to act.

Monmouth.—The Town Council have passed formal resolutions accepting the electric lighting scheme as approved by the Board of Trade and requesting an extension of the time granted by the provisional order.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending April 5 amounted to £1,256. as compared with £1,024 in the corresponding week of the previous year, being an increase of £232.

Ludlow (Shropshire).—It was decided at the Council meeting that if the Telephone Company did not make the agreement required of them within 14 days all the wires be removed. It was stated that the company disputed the right of the Corporation as to the wires.

Eccles.—At a meeting of the Electric Lighting Committee a letter was read from the Board of Trade, forwarding their approval of the proposed scheme of electric lighting for the borough, for which an application for borrowing powers had been made to the Local Government Board.

Gunnersbury (Middlesex).—The terms on which the Ealing District Council are prepared to supply current to Gunnersbury require that a yearly consumption to the value of £50 should be guaranteed, as well as the payment of interest and depreciation on the cost of the necessary extension.

Henry Pooley and Son, Limited.—This Company has been registered, with a capital of £100,000, for the acquisition, as a going concern, of the business carried on under the style or firm of Henry Pooley and Son, at the Albion Foundry, Liverpool, and to carry on thereat the businesses of producers and suppliers of electricity, etc.

City and South London Railway.—The returns for the week ended April 5 were £815, compared with £935 for the corresponding period of last year, being a decrease of £120. The total receipts for the half-year terminating as above were £13 471, compared with £13,583 in the same period of the preceding year, being a decrease of £112.

Coupon Payment.—The Submarine Cables Trust gives notice that on and after April 15 the sum of £2, on account of the coupon due April 15, 1896, will be paid by Messrs, Glyn, Mills, and Co., of 67, Lombard-street, between the hours of 10 a.m. and 2 p m. The coupons should be left with the bankers for examination four clear days before payment.

London Tramways —It is stated that a scheme is on foot by which a syndicate of tramway experts and financiers are to acquire and consolidate all the tramways in London, and work them under a lease from the County Council. Should the scheme be carried out, it is intended to substitute some form of mechanical traction for horse traction on all the lines.

Monifieth.—A meeting of ratepayers has been held to consider the question of providing some light for the burgh. Mr. R. S. Barrie, convener of the Lighting Committee, referred to electric lighting, and stated that an installation could be established for £3 500, and light supplied at something like 5s. 3d. per 1,000ft of gas. The subject was adjourned.

Sheffield.—The Sheffield Electric Light Company at the annual meeting decided to issue 3,375 additional shares at 10s. premium. These have been allotted amongst existing shareholders, and it was found that all had been taken up as allotted with the exception of 230. There were applications for 6,000 shares in excess of those at the disposal of the directors.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—In pursuance of the conditions upon which the issue of 5 per cent. Australian Government Subsidy Debentures was made, the numbers of debentures drawn by lot on April 1 will be paid off at par on July 1 next at Messrs. Barclay, Bevan, and Co., 54, Lombard-street, E C , after which date interest on them will cease.

Tighnabruaich (Argyll).—This little watering-place is the first of the Clyde resorts to have the electric light introduced in it. The installation has cost about £500. Altogether some 30 lamps have been erected, six of which are on the pier. The generating plant is situated at the offices of the mansion-house of Mr. Samuel Miller, of Glasgow, who is the laird of the property on which the village is built, and to whose initiative and enterprise the introduction of the light is due.

Personal.—Mr. Wm. H. Booth has resigned his appointment as managing engineer for Messrs. Le Grand and Sutcliff, artesian engineers, and has taken offices at 17, Shaftesbury-avenue, Piccadilly circus, where he will carry on business in steam engineering, water supply, and electrical transmission of power, etc. Mr. Booth has carried out many successful water supply undertakings for railways, breweries, manufactories, and electrical stations, notably for the London Electric Supply Corporation, Deptford.

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Whitehaven.—At the monthly meeting of the Harbour Commissioners the Electric Lighting Committee reported that they had discussed the letter from Mr. T. Brown, the town clerk, with respect to the agreement for the electric lighting of the harbour, and at an adjourned meeting of the committee it was recommended that the Board adhere to the existing agreement. The minutes were adopted.

Belfast.—At a monthly meeting of the Council the minutes of the Electrical Traction Committee were passed. These minutes contained the following resolution, which was passed: "That we are of opinion that a system of electrical traction would be of advantage to the city if a satisfactory arrangement can be come to with the tramways company, and that a committee, to be now named be appointed to meet the directors of the tramways company and report to the Council in committee"

Rathmines.—At a meeting of the Township Commissioners, the chairman read a letter from Mr. Deverill asking for an interview on behalf of the promoters of the Rathmines Dundrum, and Blackrock tramway. The committee, continued the chairman, had given all the tramway proposals the most careful consideration, and had not been able to come to any definite conclusion. He found under the Tramways Act that the proper way to deal with these matters was to call a meeting of the whole Board as a grand jury. That should be done by public advertisement. A meeting would accordingly be called, when they could receive all the deputations that desired to be heard.

St. Mary Woolnoth (London).—In the Court of Chancery on April 1, before Mr. Justice Kekewich, was heard the case of Brooke *v* the City and South London Railway Company. This was a motion by the plaintiffs, the rector and churchwardens of St Mary Woolnoth, the well known City church, for an injunction to restrain the defendant company from proceeding on their notice to treat for taking the church for the purposes of their railway. The defendants having filed an affidavit which the plaintiffs desired time to answer, his lordship directed the motion to stand over to the first motion day next sittings. Mr. Warrington, Q.C., and Mr. R. F. Norton appeared for the plaintiffs; and Mr. Cripps, Q.C., and Mr. Ingle Joyce for the defendants.

Glasgow.—The deputation from the Corporation which visited Brighton, Portsmouth, and Edinburgh to make enquiries with a view to the improvement of the street electric lighting reported that they are unanimously of opinion that, for the purpose of giving the most effective illumination and diffusing the light over the largest area without shadow, the overhanging lamp which has been adopted at Brighton is the best. The lamps in Brighton are partly 12-ampere Crompton lamps and partly Brockie-Pell lamps, run at seven amperes each, and they are suspended from an arm extending 6ft. from the pillar into the roadway at a height of 26ft. from the ground. The cost per light per annum for the Crompton lamp is £33, and for the Brockie-Pell lamp £28.

Edinburgh.—The Catholic Apostolic Church in London-street has now been fitted with a complete installation of electric lighting. The installation consists of about 160 lamps of 8 c.p. and 16 c.p. In the sanctuary hidden lights have been introduced into the dome of the baldacchino to give light to the altar and bring into prominence the colours of the marbles, while behind the baldacchino lights are hung to counteract the shadow thrown by it on the circular wall of the apse. The idea of lighting such a large building by lights invisible to the congregation is somewhat bold and novel, but the result has been a complete success. The whole installation has been carried by Messrs. Anderson and Munro, of Edinburgh and Glasgow. The Lighting Committee have resolved to light Candlemaker-row with electricity.

Tunbridge Wells.—At the meeting of the Town Council attention was called to the fact that on one evening recently the street electric lamps had all suddenly gone out, and Councillor Jenkinson asked if it would not be wise to have the gas lamps lighted to meet such a contingency. Councillor Wood assured the Council that the mishap alluded to was exceptional, and it was hoped that no future inconvenience would be experienced as the plant and appliances were more in working order. Councillor Wood moved the adoption of the report of the Lighting Committee, and reported progress with regard to the new system of lighting by electricity, and said it was proposed to extend the lighting improvements to the western suburbs of the borough beyond the Common. After a few suggestions as to the position of lamps, etc., the report was adopted.

Manchester.—At the meeting of the City Council the adoption of the minutes of the Gas Committee was moved by Mr. Alderman Gibson, seconded by Mr. Alderman Higginbottom, and agreed to. They included a recommendation that £1,600 be paid to the Westinghouse Company, Limited, in full discharge of all claims for royalty, present and future, in connection with the three wire and five-wire systems in use in connection with the electric installation in Manchester. Of the five-wire system, it was explained, Manchester was one of the largest users, and the system had proved exceedingly successful and had resulted in the making of large profits. The opinion was expressed that the arrangement with the company—made subject to the condition that the Corporation should not oppose the application for an extension of the life of the company's patents—would be advantageous to the Corporation.

Cardiff.—A special meeting of the Electrical and Lighting Committee has been held to appoint a fitter and engine drivers for the central station of the electric lighting works. Mr. Illtyd Thomas asked if the committee were not acting in antagonism to the advice of Mr. J. H. Hallett, who was of opinion that the engineer at the works should have control of these appointments. They were adopting a principle in this instance which was unbusinesslike and undesirable. Mr. S. A. Brain also thought the officials and not the members of the Corporation should deal with the positions they were now about to fill. The Chairman explained that those appointed would be subject to the engineer, who would deal with them in the event of neglect of duty or incompetency. The committee then proceeded to appoint a fitter, and the majority of the votes being recorded for Mr. W. S. Melhuish, 2, Pembroke-road, Cardiff, he received the appointment. The following were appointed as engine drivers: Messrs. Dan O'Connell, Morgan Hopkins, and Charles Collier, Cardiff.

Bolton.—Judging from the tone of the remarks made at the last meeting of the Council, Mr. Rider appears to be leaving with the good wishes of the whole of the members Councillor Proctor viewed with considerable alarm the fact that the Gas Committee were changing their electrical engineer at this particular juncture, and he felt it must be a source of regret to every member of the Council that a gentleman who had served the Corporation so faithfully and well was about to leave them. It was well known that Mr. Rider designed and carried out the electrical works, and that they were a credit alike to the engineer and to the Corporation. Some of the councillors seemed to think that if Mr. Rider had waited a little while he would have got a substantial advance in his salary, and they regretted that he should have resigned because his application was not then granted. On the other hand, it was said that when they had a good man they should have kept him; and some very pertinent questions were asked as to why the committee in advertising for a successor should have offered the very same salary they refused to Mr. Rider.

Bradford.—The *Bradford Observer* says complaints are occasionally to be heard from electric light users in Bradford with regard to the durability of their lamps and fittings since the introduction of the higher-pressure supply (230 volts instead of 115, as formerly); but they seem rarely to get as far as the engineer's department at the Town Hall, and when they do the explanation is found in unsatisfactory workmanship in the interior fittings, for which, of course, the Corporation is not responsible. There is now in the market an ample supply of lamps for the 230-volt pressure, which is coming rapidly into vogue in other parts of the country. But the smaller lamp producing firms have not yet taken up this line, as the demand is comparatively new; and it is quite possible, therefore, that purchasers who take any kind of lamp which is pressed on their attention may be supplied with 230-volt lamps of inferior quality. Upon this same topic, it will be noted that the Leeds City Council is taking up decisively electric propulsion of its trams; and Bradford, as recent remarks of the chairman of the Tramways Committee indicate, is not likely to linger longer than it can help behind Leeds in this matter.

Padstow (Cornwall).—At the meeting of the Urban District Council the Vice-Chairman called the attention of the Council to the installation of the electric light at Mevagissey. For lighting that town with 34 lamps during 10 months of the year the Parish Council were going to pay only £48, whereas in Padstow £60 per year was paid for about seven months. From calculations and enquiries he had made, the streets of Padstow could be lighted, as now, if the town possessed electric plant, for less than £30, a saving of one-half or more, and almost sufficient to pay the interest on the capital necessary, a little over £1,000. In his opinion, electricity was not only the illuminant, but the motive power of the future; and if the Council were to erect machinery for its manufacture, it would be a profitable undertaking, and add greatly to the financial and general prosperity of the town. An abundance of light at a reasonable price and an adequate water supply were two essentials to the well-being of a town, particularly to one claiming to be a health resort. If water and the electric light were introduced at the same time the expense would not be very heavy, and ultimately both prove paying concerns.

Lambeth (London).—Messrs. Julius Sax and Co. have been selected by the Electric Lighting Committee of the Lambeth Vestry to receive the provisional order for electric lighting. The whole of the scheduled streets are to be laid with mains, the charge is to be not more than 6d. per Board of Trade unit, and a dust destructor is to be provided. The firm have agreed to maintain and supply current to 25 arc lamps, in such positions in the compulsory streets as the Vestry may direct, free of charge. The period to be mentioned in the transfer agreement will be 31 years from the date of the agreement. At the end of 21 years the Vestry will have the right to purchase the undertaking at 25 per cent. above the then value as determined by arbitration. Messrs. Sax have agreed to treat all parish refuse at 1s. 6d per ton in the destructor. This is 8d. cheaper than under the present system. Messrs. Manlove, Alliott, and Co. will be responsible for the destructor, and Mr. R. W. Weekes, A.M.I.C.E., A.M.I.E.E., the consulting engineer, will have charge of the electric lighting. There is some discussion as to whether the dust destructor shall be adopted in conjunction with the lighting scheme of Mr. Sax; but in the event of its being rejected Mr. Sax reserves to himself the right to charge 6½d. per unit for the electricity supplied to consumers.

Cheltenham.—The General Purposes Committee have instructed the electrical engineer to proceed with the work of wiring the Council-chamber, mayor's room, committee-room, and the rate and water offices so far as the same can be done at a cost not exceeding £50. The Lighting Committee have received a report from the borough surveyor on the lighting of the south ward, in which he suggested that the 12 lamps now standing between Thirlestaine-road and the Norwood Arms should be

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replaced by electric incandescent lamps as an experiment, and the electrical engineer having reported that this could be done at a charge of £3 per lamp so as to return a small profit to the electric light department and secure a large increase in the illuminating power it was resolved that as soon as the consent of the Local Government Board had been received to the extension to Thirlestaine House the suggestion should be carried out. The report of the electric inspector of the result of his tests of the supply of electricity during the month shows an average of 103 volts, the legal standard being 100 volts for low pressure cables. The electrical engineer has obtained quotations for the supply of service cable during the remainder of the year, and recommends that all service cable required be obtained from Callenders. The number of 8 c p. lamps connected to the mains was about 6,150, and the number waiting to be connected about 700.

The Central London Railway. – A case in which the Kensington Woodhouse Park Syndicate, Limited, claim £32 790 as compensation from the Central London Railway Company for the compulsory acquisition of their property has occupied Mr Under-Sheriff Burchell and a special jury for two days at the Sheriffs' Court, Red Lion-square. The estate in question is situated at Shepherd's Bush, and covers an area of 10 acres. It is required by the Central London Railway Company for the construction of a terminal and generating station for the new underground line which they are about to lay from Shepherd's Bush across London to the City. The plaintiffs claim that their property is of exceptional value for exhibition purposes, to which use it has been already put. The defendants, on the other hand, point out how unsuccessful financially exhibitions already held in the West of London have been. The claimants are represented by Mr Littler, Q.C., and Mr. Edmonston, whilst Mr. Freeman Q.C , and Mr. Boyle appear for the railway company. A number of witnesses have been called on behalf of the claimants to prove the value of the property to its owners both for exhibition purposes and for development as a building estate. Mr. J. Hart, who had been officially connected with the Empire of India Exhibition, stated that the site at Shepherd's Bush was wholly unsuitable for the purposes of an exhibition, and if the experiment was tried he felt sure large sums of money would be dropped. After further evidence, the case was adjourned to 18th inst.

Pemb oke (Dublin).—A special meeting of the Commissioners has been held for the purpose of considering the scheme of tramway extension and alterations promoted by the Dublin United Tramways Company, and embodied in their memorial to the Lord-Lieutenant in Council, and also another scheme of tramways extensions promoted by the Rathmines, Dundrum, and Blackrock District Tramway Company. Mr. Manly, the secretary, submitted the notice of the scheme of the Dublin United Tramways Company, setting out the various proposed lines. The scheme includes lines on the Pembroke-road, Clyde-road, Wellington-place, Waterloo-road, Anglesea road, Stillorgan road, Eglinton-road, Milltown-road, Ringsend road, Bridge street, and Thomas-street, Ringsend; Irishtown road, and Upper Baggot-street. The secretary also read the notice of the Rathmines, Dundrum, and Blackrock District Tramways Company, which proposes to run over Milltown-road and Eglinton road. He stated that the solicitors for the Southern District Tramways Company were under the impression that the present meeting was the enquiry contemplated by Section 5 of the Tramways Act of 1860, at which all parties could be heard by the Board as a grand jury. The secretary further explained that the law adviser had given it as his opinion that this was not so, and, having informed the Southern Tramways Company that such was the case, they had lodged a memorial with the Board complaining of non-compliance with the statutory requirements on the part of the United Tramway Company. A formal resolution was passed disapproving of the proposed order.

Lincoln.—The Special Electric Lighting Committee having considered the question of producing electricity in the city had engaged Mr. J. Hopkinson, D Sc., F.R S., etc., to inspect the city and report. They had considered his report, and recommended that it was advisable to supply electricity in the city, and that in their opinion the most advantageous means of providing such supply would be the system described in the report made to the committee by Dr. Hopkinson. They requested to be empowered to take such steps and proceedings as were necessary in order to vest in the Corporation the powers of the Electric Lighting Acts. At the meeting of the Council Alderman Page, in moving the adoption of the report, said the consideration of the subject had led the committee to the unanimous conclusion that if not during the first few months, at any rate during the early period, the undertaking would be self-supporting if the initial cost was not extravagant. He contrasted the high-tension alternating system with the low-tension continuous current, and said that the committee had received valuable statistics from a vast number of towns, and almost without exception—in fact, it was almost universal—that within a period of three years the electric lighting system was self-supporting, and demands for the current increased greatly. They might easily embark on finding the sum of £15,000 which would be necessary for the installation. If the Corporation empowered the committee to set to work, they would find a site and then make recommendations as to the method of carrying out the proposal. Mr. Turner seconded, and the report was adopted

Newcastle-under-Lyme.—Major Marindin, R E., inspector of the Board of Trade, who, a few weeks ago, held an enquiry as to the objections of the Corporation to the provisional order applied for by the promoters of the Potteries Extension Tramways, empowering them to construct a line between Newcastle and Hanley, *vid* Etruria, has forwarded his report to the Council. He comes to the conclusion that in some respects the objections lodged by the Town Council to the laying of the tramway within the borough had been shown to be well founded, and that the promoters had failed to establish their contention that the assent of the Town Council to the making of the tramway according to the present scheme and without any modifications of the order should be dispensed with. He considered that the scheme did not offer advantages which Newcastle might fairly claim, inasmuch as it merely provided a route between Newcastle and Hanley, and did not facilitate communication between Newcastle and the districts surrounding it. With regard to the tramways asked for by the Town Council to Silverdale, Chesterton, Wolstanton, and Trent Vale, he thought that the first two were the most essential, and that the third should be undertaken if the tramway between Wolstanton and Burslem be made, as this would supply a want and provide a through route from Newcastle to Burslem and Goldenhill; but he did not think that a case had been made out for a tramway to Trent Vale The Council were clearly not adverse to tramways, and a large majority of the ratepayers desired them, and he therefore considered that if the promoters would consent to be bound by a clause with the following conditions, the construction of the proposed tramway within the borough of Newcastle should be sanctioned, and the assent of the Town Council dispensed with if after further consideration of the terms proposed they did not decide to give it. The clause he suggested was that the promoters being given power to construct the tramway should be bound not to use this power so far as that part within the borough of Newcastle was concerned until they had obtained powers to construct tramways to Silverdale and Chesterton, and had exercised those powers. They should also give an undertaking to promote a tramway between Wolstanton and Newcastle if they exercised their power to construct a tramway from Burslem to Wolstanton.

International Electric Railway Prize Problem.—The president of the commission in charge of the design and construction of the mountain railway in Switzerland to the top of the snow-clad Jungfrau Mountain has issued the following information concerning the prizes offered for the solution of certain problems involved in the construction of this road. The total sum of the prize offered is 30,000fr. (£1,200) for the best solution of a number of questions which are involved in the construction and operation of this road. The chief points involved are the following: (1) in the laying out of the road—the profile of the tunnel, the roadbed and elevated structures, the rails, rack, switches, and crossings, the best system for transmitting the electrical energy, protection against interruption by atmospheric conditions, rolling stock, project for the construction of the station and restaurant at the Eiger Glacier Station, design of the station (presumably near the top), which is to be bored out of the solid rock, an elevator of a height of 100m. and 8m. in diameter to the top of the mountain; (2) in the construction of the road—methods of boring the tunnel, and all problems connected therewith; (3) in the operation of the road—precautions and devices for assuring continuous operation and preventing interruptions, methods of lighting and heating the tunnels, cars, and stations. Solutions of one or more of these questions may be offered by single individuals or by several collectively; solutions of other questions not enumerated which are deemed of importance in the construction of this road, will also be accepted. The Scientific Commission will decide on the value of the answers, and their results will be published. By offering the prizes the company reserves the right to adopt the solutions for which prizes are offered without further cost on this road only; solutions which do not receive prizes will be returned. The following information is added: the maximum grade is 25 per cent. the gauge 1 metre, the smallest radius 100 metres, the smallest "ausrundungsradius" 500 metres, the greatest width of rolling-stock 2·50 metres, and the greatest height 3 metres, the allowable speed 7 to 10 kilometres per hour. The water power for generating the current amounts to about 5,000 h.p, and will be taken from the two Luetchinen; from the turbine to the beginning of the road the distance is about 8 kilometres, and from there to the beginning of the tunnel 2·5 kilometres; the tunnel has a length of 10 kilometres. Applicants for prizes should send drawings or models, if necessary, as also estimates of cost. Papers will be received up to August 1, 1896. Further information may be obtained from the Bureau der Jungfraubahn, Bahnhofstrasse 10, Zurich, Switzerland.

Leeds.—At a meeting of the City Council a long discussion took place on the proposed electric tramways. Mr. Willey called attention to the following letter, written to the chairman of the Highways Committee (Mr. Hannam) by Dr. Hopkinson with regard to the construction of the tramways: "Dear Sir,—My terms for preparing specifications and supervising the carrying out of the works in connection with your proposed system of tramways in Leeds would be 5 per cent on the cost of the work up to forty thousand pounds (£40 000), and 4 per cent. on anything beyond that sum. It would be understood that this commission would only extend to such parts of the work as you might think fit to put in my hands, that I should bear all my own costs, whether for assistance or for travelling, that the Corporation should provide and pay their own clerk of works, and that from the commission first payable the sum of five hundred pounds (£500) should be reserved for the purpose of paying for my services in generally advising as consulting engineer for one year after running had begun, and to be payable at the end of that year. I understand that in the event of my being appointed it is the intention that the whole of the electrical work should be placed in my hands, including the cars and the engines, and the

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buildings, laying of the road, etc., would be done by yourselves. But, of course, in that event, I should be very willing to give the necessary indications as to space to your engineer, and should be glad to look at the plans before they were carried out, with a view to making any suggestions which might occur to me.—I am, dear sir, yours truly, J. HOPKINSON. P.S.—These terms are independent of, and in addition to, the fee now payable to me for my report.—J.H." Mr. Hannam in replying, said the committee asked to be allowed a free hand in the matter. They had a system in view which they believed would be the best, either in this country or out of it. With regard to Dr. Hopkinson's appointment, he thought that a matter which ought to be left in the hands of the committee, who would carry out the enterprise at the lowest cost. The question of fares had been thoroughly discussed by the committee, and it was felt that Leeds was behindhand in the matter of penny stages. The reduction of fares and a quicker service on the Hunslet and Kirkstall lines had resulted in an increase of between £20 and £30 a week in the receipts, and he thought the traffic would be trebled in consequence of the reduction now proposed. The complaints made as to delays on the different lines should be brought before the committee. The minutes of the Highways Committee were adopted, and thus the Council approved of the terms contained in Dr. Hopkinson's letter, with the exception of that relating to the work connected with the engines and cars being placed in his hands. The adoption of penny stages on the Chapeltown and Headingley routes was also likewise sanctioned.

Llandudno.—At a special meeting of the District Council, the report of Mr. A. H. Preece on the establishment of an electric supply station combined with dust destructor and electric tramways was submitted. Mr. Preece said he had carefully considered the probable immediate demand, and he estimated that it would be sufficient if plant were installed for about 4,000 8 c.p. lamps burning at one time; that would be equivalent to about 6,000 lamps fixed in consumers' premises. The question of the system to be used depended entirely on the position of the generating station. The report estimated that the cost of the installation would be £20,500; that the annual working expenses would be £2,085; and the revenue £3,250. The gross profit would be £1,165 and after deducting for interest and sinking fund about £1,100, the net profit would be about £65. In dealing with electric lighting combined with a refuse destructor, Mr. Preece estimated that the cost of the combined scheme would be £23 400, £2,900 in excess of the electric supply station alone Therefore, estimating the destructor at £3 700 by itself, about £800 would be saved by combining the two plants. In reporting on the addition of an electric tram scheme to the above, Mr. Preece says: "I feel sure that a tramway at Llandudno along the parade to Craigside and along Mostyn-street at any rate would be of great advantage to the electricity supply station if it were called upon to supply energy for the purpose, but whether the Corporation lay down and equip the tramway themselves or leave it to a company is a matter which is entirely for them to decide. In this report I do not propose to go into the policy and probable cost or financial gains which would be made from the tramway; the point which I wish to show is that the establishment of an electric tramway in Llandudno would be of appreciable advantage to the electricity supply station, and it would tend to reduce the cost of the electric light. The additional capital expenditure required to make the necessary provision for tramways would be £4,600." In conclusion, Mr. Preece says: "I recommend the committee to adopt the second scheme, and to consider the necessary steps to be taken so that the second scheme may be enlarged ultimately to enable electrical energy to be supplied to a tramway as in the third scheme. I feel confident that a triple scheme as described will be a certain success. The reduction in the cost of electricity supplied to private consumers is bound to lead to an increased demand for light, and in the near future you will be in a position to supply light at an exceedingly cheap rate. The cost of street-lighting by arc lamps will be small, and the finances would be greatly improved by the profits which are certain to arise from the successful administration of those local industries." It was decided to hold a special meeting to discuss the proposals.

Brighton.—At a meeting of the Lighting Committee a letter was received from the Glasgow Police Commissioners (Lighting Department), a deputation from which recently visited Brighton, asking for certain information with regard to the public lighting by electricity, and adding: "Our committee were very much struck by the fine appearance of your pillars." At the meeting of the Town Council, Councillor Stafford moved the adoption of the proceedings, and said he understood the Glasgow Committee were paying Brighton the compliment of imitation in street-lighting, and he thought it something to be proud of. The proceedings were confirmed. The Lighting Committee submitted a report by the electrical engineer with reference to raising additional capital for the purposes of the electricity undertaking. As showing the rapid extension of the demand and use of electricity in Brighton, he submitted figures showing that the number of consumers was as follows: March 23, 1892, 100; March 23, 1893, 226; March 23, 1894, 454; March 23 1895, 872; March 23, 1896, 1,121. It appeared also that this rate of increase was likely to be maintained, as the rate of receiving new applications for the supply this year was more than 85 per cent. greater than in the corresponding period of any other year. The most sure sign of the healthy development of the business, however, was the increasing rise in the sales of electricity year by year. These had been (excluding all electricity used in public lamps): 1892, 22,000 units; 1893, 44,000 units; 1894, 78,000 units; 1895, 148,000 units; 1896, 228,000 units. These figures, Mr. Wright holds conclusively proved the commercial soundness of the policy pursued by the committee in constantly extending the electric mains in all directions within the borough, in arranging the tariff so as to enable the small householder to derive the benefits of the electric light as readily as the rich, and in gradually increasing the size and capacity of the generating station so as to enable it to cope with the increasing demand. He thought it would interest the committee to learn that the cost of producing electricity in Brighton in 1895, exclusive of coal, the cost of which depended so much on the geographical position of the towns compared, was again lower than that of any other town in England whose accounts had as yet been published Mr. Wright proceeded to point out the need of fresh capital for house service, meters, extending mains, etc., and for additional plant in the generating stations. He estimated that £23,000 would be required for fresh capital on electricity works accounts, and £4,500 for work in connection with street lighting, making a total of £27,500 The committee concurred in the recommendations of the engineer, and recommended that application be made to the Local Government Board for sanction to borrow the sums of £23,000 on the electricity works account for a period of 25 years, and £4,500 on the district fund account for a period of 15 years. Councillor Stafford, in moving the adoption of the report, said it was so comprehensive as to need few words from him. There was no doubt the success of the electric light in Brighton was largely owing to the adoption of street-lighting. It was his privilege last week to visit a generating station in the North of England, where the engineer regretted very much he could not make the lighting profitable, as the Council would not adopt street-lighting. Since the street-lighting the applications to the committee had increased greatly, and even since the report they had had 84 applications, as against 45 in any previous year. The motion was seconded, and carried unanimously.

Newington (London).—Major Philip Cardew, R.E., has held an enquiry on behalf of the Board of Trade to hear objections to the provisional order which is being promoted by the Newington Vestry with the object of obtaining powers under the Electric Lighting Acts to supply electricity in the parish. Mr. Morton W. Smith, barrister, appeared for the Vestry in support of the order. Mr. Wheeler, Q.C. and Mr. T. Dale Hart, LL B, represented the Newington and Walworth Ratepayers' Association. Counsel also appeared for the two companies who have lodged objections to the Vestry's scheme. Mr. Morton Smith explained that when the Electric Lighting Acts were first passed, in 1882, it was proposed that only one authority or one company should exist in one area. The Newington Vestry in 1883 contemplated applying for a provisional order, but in consequence of opposition the matter dropped. In 1888 a new Act was passed in favour of competing orders. Thereupon a number of provisional orders to supply Newington were applied for, and one was secured by the London Electric Supply Corporation, but up to now this company had only laid down a few mains. Last year or the year before the County of London and Brush Provincial Electric Lighting Company applied for a provisional order, but as the Vestry had expressed the opinion that the power to supply electricity ought to be reserved to the local authority, the Board of Trade declined to allow the company's application to be proceeded with, so that the Vestry might apply for power to supply the parish. The general idea was that these powers could be better exercised by local authorities for the profit of the ratepayers than by a company. Moreover, the Vestry could supply electricity much cheaper than a company. Against the scheme of the Newington Vestry there had been various petitions lodged with the Board of Trade. The first was that of the London Electric Supply Corporation, the company which obtained an order to supply Newington in 1889. This corporation stated in their objection that they had executed the necessary works and made the necessary arrangements for supplying electrical energy, and were both able and willing to supply all such demands as would arise. They contended that no sufficient grounds existed why further powers should now be granted to the Vestry. In reply to this, the Vestry would point out that Section 1 of the Electric Lighting Act, 1888, was expressly passed to enable the local authority to be granted a provisional order, notwithstanding that some company or corporation had already obtained a license or provisional order for the parish. The corporation in question had only laid mains along the street from St. George's Church, High-street, Borough, down Newington-causeway and Walworth-road to Deacon-street. They had not complied with the terms of Clause 23 of their order, for no main had been laid, so far as the Vestry could ascertain, in Newington-butts, nor to the full extent of Walworth-road, as specified in the schedule—*i.e.*, to Wansey-street. Having failed to carry out their duty under Clause 23 of their order, the corporation was liable to have their order revoked under Clause 25. The second objection was lodged by the County of London and Brush Provincial Electric Lighting Company, who held that the special circumstances of Newington were such that an electrical undertaking limited to that parish could not possibly earn sufficient revenue to pay its expenses, and that the only practicable way of obtaining a supply of electricity for Newington was to make it part of a larger area, such as that now being applied for by the objectors, who were prepared to undertake the supply of electricity in Newington as part of their larger undertaking. The Vestry believed that this company would be equally unable to supply energy at a sufficiently low rate. He now came to the petition of the Newington and Walworth Ratepayers' Association. There was, he said, every reason to believe that the opposition arose from purely interested and party motives. The Vestry admitted it would be unfair to tax all the ratepayers for the

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benefit of those residing in the main roads. This was not the intention of the Vestry's scheme As the Board of Trade knew, the electrical supply stations in the hands of the local authorities did not prove burdens upon the rates. There was no idea on the part of the Vestry to enter upon this scheme as a speculation. They would be well advised by competent engineers before moving to give effect to the order if granted, and if it should be found after due enquiry and investigation that Newington was a parish in which electrical energy could not be supplied with success then there would be power under the order to contract with a company for the supply. A great number of witnesses were called, and it was stated that the Vestry proposed to spend £28,000 on the undertaking. This sum was made up as follows: land, £1,700; buildings, plant, and works (including generating station), £26,000; and contingencies, £1,000. The capital expenditure was estimated to supply 8,000 or 9,000 lamps. The principal grounds of objection appeared to be that the locality did not require it, that the people would not take the electric light when laid, that the scheme was too incomplete, that it was a speculation, and that the parish was too heavily rated at the present time to be able to bear a further increase. The enquiry lasted three days.

PROVISIONAL PATENTS, 1896.

MARCH 30.

6890. System of distribution of electrical currents. Salomon Berditschewsky, called Apostoloff, 53, Chancery-lane, London.

6925. Electric water gauge. Hermann Biermann, 115, Cannon-street, London. (Complete specification.)

MARCH 31.

6943. An automatic electric light door switch. Walter John Fryer, Danecroft, Silverdale, Sydenham, London.

6958. Improvements in controlling gear for electrically-propelled carriages or trucks. John Dalrymple Bell, 87 St. Vincent-street, Glasgow.

6980. An improved electric boat-propeller. Joshua Entwisle, 5, John Dalton-street, Manchester. (Samuel Newton Smith and E. S. Baring-Gould, United States.) (Complete specification.)

6981. Improvements in electric batteries. Joshua Entwisle, 5, John Dalton street, Manchester. (Samuel Newton Smith and E. S. Baring Gould, United States.) (Complete specification)

6993. An improved coin-freed electric meter. Robert Hacking, 78 Fleet-street London.

7000. A process and apparatus for decomposing sodium or potassium chloride and generating electricity. Ludwig Epstein and Frederich Marza, 28, Southampton-buildings, Chancery-lane, London.

7005. Improvements in electric hammers and the like. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Arthur S. Barnes and Perry S. Skinner, United States.) (Complete specification)

7013. Improvements in electric meters. James Devonshire, 70, Chancery-lane, London. (Charles P. Steinmetz, United States.) (Complete specification.)

7038. Improvements in regulators for electric arc lamps. Hermann Bäurlin, 18, Buckingham-street, Strand, London. (Complete specification.

7054. Improvements in electrical signal systems for railways Louis Charles Werner, 40, Chancery-lane, London. (Complete specification.)

APRIL 1.

7074. An arc lamp for high voltages. Alfred John Beaumont, 6, Scarcroft-road, York.

7121. A new method of making shades for gas, electric, or other lights. Arthur Felix Davies, 82A, New Bond-street, London.

7140. Improvements in mechanism for driving clocks and dials by electricity. Arthur Joyce, 6, Lord-street, Liverpool.

7151. Improvements in differential automatic switches. Francis Henry Nalder, Charles William Scott Crawley, and Alfred Soames, 16, Red Lion-street, Clerkenwell, London.

7161. Improvements in or relating to electric light fittings. Frederic Augustus Chapman, 111, Hatton-garden, London. (Complete specification.)

7162. Improvements in or relating to secondary batteries. Alfred Julius Boult, 111, Hatton-garden, London. (Jules Julien, Belgium.)

7166. Improvements in electric fire-alarms. Michael A. Shanahan, 40, Chancery-lane, London.

APRIL 2.

7174. A metal for heating by electricity. John Chester Green, Winnipeg, Manitoba, Canada.

7195. Improvements in dynamos. Sebastian Ziani de Ferranti, 27, Charterhouse-square, London.

7232. Improvements in apparatus for manufacturing tubes by electrolytic deposit. Alexander Stanley Elmore, 28, Southampton-buildings, Chancery-lane, London. (John Oliver Surtees Elmore, India.)

7237. Improvements in electric fire-alarms. Isaac T. Bomar, 40, Chancery-lane, London.

7254. Improvements in electric igniting devices for gas burners. Gottfried Ferdinand Krieger, 45 Southampton-buildings, Chancery-lane, London.

7255. Improvements in secondary batteries. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Jules Julien, Belgium)

7259. Improvements in and in the construction of soluble-metal electrodes for accumulators. William Phillips Thompson, 322, High Holborn, London. (Jules Julien, Belgium)

APRIL 4.

7318. Improvements in electric heaters. Edward Ethel Gold, 55, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1895.

11478. Electrolytical separation of metals from their ores. Johnson. (Pelatan and Clerici.) (Second edition.)

5205. Secondary battery plates. Luckow.

8453. Electric switches. Brockie.

9380. Electric-firing pistols for gun mountings. Lloyd and Brankston.

9442. Insulating electric conductors. Hardingham. (Felten and Guilleaume.)

9504. Incandescent lamp shades. Barratt and others.

9636. Arc lamps. Siemens Bros. and Co., Limited, and Booker.

10277. Measuring electric currents. Siemens Bros. and Co., Limited, and Lauckert.

11544. Telegraph poles, etc. Bullers, Limited, and Chambers.

21460. Electric motors. Morgan.

24711. Electric brakes. Devonshire. (Potter.)

1896.

474. Electrically-propelled vehicles. Bersey.

780. Secondary electric batteries. Leitner.

3032. Electric railway signalling apparatus. Krapf.

3093. Dynamo-electric machines. Devonshire. (Knight and another)

3094. Regulating alternating currents. Devonshire. (Berg)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1¼-1⅝
—— Non. Cum., 6 per cent. Pref.	2	1⅝-1¾
—— 4½ per cent. Debenture Stock	100	110-113
Charing Cross and Strand	5	7¼-7½
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7⅛-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16½-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-2¾
Edison and Swan United Ordinary	3	1¼-1⅞
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	1⅝-1⅞
—— 7 per cent. Cumulative Pref.	2	2⅛-2¼
Elmore's Copper Depositing	2	⅞-1
Elmore's Wire Company	2	⅞-1
Fowler-Waring Cables	5	½-¾
W. T. Henley's Telegraph Works, Ordinary	10	16½-17½ xd
—— 7 per cent. Preference	10	16½-17½ xd
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	3½-3¾
—— 7 per cent. Preference	5	7½-8¼
India Rubber and Gutta Percha Works	10	20-21
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge Ordinary	5	8½-8¾
—— 6 per cent. Pref.	5	7½-7¾
Liverpool Electric Supply, Ordinary	5	7⅝-7¾
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	16⅜-16⅝
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	8-8⅛
Metropolitan Electric Supply	10	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	6¾-7
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref	5	6⅝-6¾
—— 3½ per cent. Deb. Stock	100	106-109
Notting Hill Company	10	8¾-9½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105 xd
Southampton Electric Company	5	4½-5½
St. James's and Pall Mall, Ordinary	5	9½-10½
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	6	8½-8¾
Westminster Electric Supply, Ordinary	5	9½-10½
Yorkshire House-to-House	5	7-7½

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NOTES.

Moving Pictures.—Colour has been added to Mr. R. W. Paul's moving pictures.

Copenhagen Academy.—Lord Rayleigh has been appointed a foreign member of the Copenhagen Academy of Science.

The Crystal Palace School.—The distribution of certificates at the Crystal Palace School of Practical Engineering takes place to-day (Friday), under the presidency of Mr. A. T. Walmisley, M.I.C.E.

Copper.—It is stated that in the long-distance plants installed by the General Electric Company in the United States during 1895, over 1,200 miles of copper wire for transmission purposes alone were used, amounting practically to 1,200,000lb. of copper.

Presentation.—On the occasion of leaving the Crichton Royal Institution, Dumfries, Mr. W. B. Edgar has been presented with a handsome gold chronograph by the electrical staff and a few friends. Mr. Edgar, on leaving Dumfries, will join the staff of Messrs. Johnson and Phillips, Charlton, Kent.

Robbing a Tramcar.—According to the *Western Electrician*, the two men who last October "held up"—*i.e.*, stopped—an electric tramcar and robbed the passengers in it between Chicago and Evanston, have been caught, tried, and convicted. The sentence is not stated. It is noteworthy that, in spite of the conviction, our contemporary still speaks of the men as the "alleged robbers."

Military Telephones.—In the *Compte Rendu* of the proceedings of the Société des Ingenieurs Civils de France a communication appears from Captain Charollois on the subject of telephoning through bare wires laid on the surface of the ground. With a 6mm. wire laid through wet grass and an earth return, Captain Charollois obtained perfect communication over a distance of four miles. The details, however, are not given.

Military Telegraphs.—In a serial article on Italian military telegraphs, *L'Electricien* describes the light cable lines used for temporary purposes. These are hung on trees or hedges, laid on the ground, or even when necessary laid beneath it. The core is copper wire, insulated with indiarubber and covered with hemp treated with zinc-white. As long as the covering is in good condition the cable can be taken through marshes and rivers, but for torrents and rapid streams an armoured cable is used.

Imperial Institute.—The exhibition of motorcarts to be held at the Imperial Institute in May and all through the summer months is to include vehicles propelled by steam, oil, electricity, and springs. It will be interesting to see whether examples of the last will be forthcoming; there seem to be difficulties in the way of a clockwork coach outside of toyland. There is also to be a section for apparatus for aerial navigation—in other words, flying machines—and a section devoted to stationary engines, dynamos, and motors.

Voltage Regulator.—The Hopfer and Eisenstuck apparatus for maintaining the voltage constant either at the dynamo or any other point has been described in the *Elektrotechnischer Anzeiger*. It consists essentially of a wire resistance, successive portions of which are brought into the circuit by means of a mercury-cup which is moved up and down below the ends of the wires, each successive one of which is shorter than the preceding. It is operated by a shunt magnet through a system of levers, which are arranged so that they may be accurately balanced by means of sliding weights.

The Iron and Steel Institute.—The spring meeting of the Iron and Steel Institute of Great Britain will be held on Thursday and Friday, May 7 and 8 next, at the Institution of Civil Engineers, Westminster, under the presidency of Sir David Dale. Upon that occasion the Bessemer gold medal, which is awarded annually in recognition of meritorious services in advancing the science or practice of the metallurgy of iron and steel, will be presented to Dr. Hermann Wedding, of Berlin. The list of papers down for reading and discussion is a full and comprehensive one.

A Brilliant Invention.—The application of electricity to heating purposes is a favourite subject for the inventor. The last thing in this way is a suggestion, reproduced in the New York paper *Electricity*, that the drivers of electric tramcars should be kept warm in the winter by a coat having a resisting network of wires woven into it and connected with the trolley circuit. The suggestion comes from Texas instead of one of the Northern states, and it is almost a pity that it is not more practical, if only on account of the beautiful Greek name that would be manufactured for an electric self-heating overcoat.

Lightning Arrester.—A new lightning arrester, designed by Mr. Ohlinger, of Paris, is described in *L'Industrie Electrique*. It consists essentially of about 20 circular plates of tin, insulated from each other by the same number of plates of micanite. These latter are of about 4mm. greater diameter than the tin plates, so that they project and prevent arcing. The plates are perforated in the centre and threaded on a rod, so as to form a vertical cylinder, and the whole is covered with a porcelain bell. The arrester is said to be suitable to both high and low tension lines, and it is said to have been used with tensions up to 10,000 volts.

A Swiss Waterfall Plant.—The *Schweizerische Bauzeitung* gives an account of the utilisation and distribution of energy derived from the fall of La Goule in the Bernese Jura. The area of supply covers about nine villages or small towns. The motive power is derived from four turbines of 500 h.p. each. These are coupled direct to Oerlikon alternators running at 200 revolutions a minute, and supply high-tension current direct to the line. The frequency is 50 and the voltage 5,000, which is transformed to 240 volts on three-wire systems for lighting and to 220 volts for power. The line is carried on wooden posts, and the total length is about 21 miles.

Swedish Exhibition.—According to *Kuhlow's German Trade Review*, the arrangements for the Stockholm exhibition have been completed. It will take place in 1897, and everything is now being done to make it as representative and comprehensive as possible. Matters are being pushed ahead with much vigour, and all parts of the country appear to take the keenest and most active interest in the success of the undertaking. The exhibition will contain sections devoted to engineering, machinery, shipbuilding, electricity, scientific appliances, etc. It is added that the site of the exhibition, about which there was at one time much disagreement, leaves nothing to be desired.

Society of Arts.—The council of the Society of Arts have announced the offer of the Fothergill Prize of £25 and a silver medal for a paper on "The Best Means of Effectually Preventing the Leakage of Current to Earth in Electrical Installations from Generating Heat and Setting Buildings on Fire" The paper should consist of about 8,000 words, and be written with a view to being read and discussed at an ordinary meeting of the society. All papers submitted for the prize should be sent to the secretary before October 1, 1896. They must be type-written, and

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bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto in the usual way.

Hungarian Exhibition.—A meeting of the British Committee in connection with the Hungarian Millennial Exhibition to be opened at Budapest on May 2 was held on Tuesday at the Mansion House, the Lord Mayor presiding. The subject of communications and cheap tickets having been discussed, a report on the general progress of the exhibition was submitted by Mr. Felbermann, who stated that it was nearly completed. He hoped that a great many English people would pay it a visit. If they did he could assure them that they would be warmly received by the Hungarians, who entertained a grateful feeling towards the British nation for having been so kind to them in days gone by.

Carbides of Yttrium and Thorium.—Messrs. Henri Moissan and Etard have described the carbides of yttrium and thorium prepared by them with the electric furnace. The composition in each case corresponds to the formulæ YC_2 and ThC_2. Both decompose water, the yttrium carbide giving about three-quarters acetylene and the rest methane with a small quantity of ethylene and hydrogen. Thorium carbide gives more methane and hydrogen, besides a small quantity of liquid hydrocarbons. The colour of the thorium carbide appears to be yellow, but it is liable to be masked by the presence of residual carbon in the form of graphite. With a current of 900 amperes at 50 volts the reduction to carbide of about 2½oz. of oxide appears to have taken four minutes.

Utilising Water Power.—The utilisation of a more or less distant water power for manufacturing purposes by means of electrical plants appears to be making steady progress on the Continent, especially in those countries where cheap coal is not obtainable. In this week's issue of *L'Elettricità* three new installations of this kind are noted in Italy. The first is for a cotton mill at Capriolo, in Brescia, and the distance which the current is conveyed is hardly over 100 yards. The second is also for a cotton mill at Ponte San Pietro, in Bergamo. It is an 800-h.p. plant, and the current is conveyed about 2½ miles, something like 200 h.p. being apparently lost in the process. The last is a small affair of only 13 h.p. on the estate of Prince Borghese, at Fossanova, in the Pontine Marshes. The current is, however, conveyed over three miles, and used for purposes connected with agriculture. In each of these three cases triphase or polyphase currents are used.

Three-Phase Currents.—It is remarked in the *Revue Industrielle* that recent applications have shown the practicability of increasing the range of central stations serving electric tramways by the use of three-phase currents. With a maximum potential of 500 volts, the expense of copper limits the length of the line which can be run from a single generating station, but the difficulty can be avoided by having a number of small sub-stations along the line containing a motor transformer which gives a continuous current at 500 volts, and is worked by a high-tension three-phase current. Our contemporary, after describing the Lowell and Lakeview line, in Massachusetts, and the Dublin, Blackrock, and Dalkey tramways, concludes that this system of working will play an important part in the future of electric traction, "since it supplies a simple, elegant, and practical solution of the problem of communication with villages and places where, on account of its cost, an ordinary railway service would be impossible."

Changing to Three-Phase.—In describing the new work carried out at Bourganeuf, in the department of the Creuse, *L'Electricien* remarks that the conveyance of energy by electricity is progressing slowly but methodically in France. The Bourganeuf installation is about eight years old, and takes its power from the Jarraud cascade, about 8½ miles distant. It has now been completely remodelled to work with three-phase currents and give much greater power, so that of the old work little but the station buildings is preserved. The motive power is derived from two horizontal turbines of 225 h.p. each. Current is generated at 80 volts and transformed to 9,000 volts for transmission along the line, the wires being carried on high poles. At Bourganeuf part of the current is transformed down again to 110 volts, and converted into a direct current for lighting and charging accumulators, and the rest is used to supply power to a paper-mill. For this purpose it is transformed down to 100 volts, and works two three-phase motors of 120 h.p. and 15 h.p. *L'Electricien* considers that this installation as now remodelled is of a type which under many circumstances may render great service to municipalities and manufacturers.

Personal.—The Blackpool *Gazette and News* refers to Mr. J. Hesketh's marriage and his departure for Australia in the following terms: "We must heartily congratulate Mr. John Hesketh, the borough electrical engineer, upon an approaching 'double event.' In the first place, Mr. Hesketh's marriage to Miss Laurie Hinnell, daughter of the town clerk of Bolton, takes place at Rivington on Tuesday, and we wish them every possible happiness. Then this week Mr. Hesketh has received news of his appointment as electrical engineer to the Government of Queensland. Considering that there were over 100 applications for the post, Mr. Hesketh must indeed consider himself fortunate. The commencing salary of the office is £600 a year, with travelling expenses, and Mr. Hesketh's duty will be to advise on all matters connected either with telegraphy, telephones, electric lighting, and electric tramways in this rapidly-growing colony. Mr. Hesketh will have to cover a lot of ground in the discharge of his duties, but he believes that the work will exactly suit him. Mr. Hesketh's resignation of his position at Blackpool has been placed in the hands of the Electric Lighting Committee, and we understand the committee decided to at once advertise for a new electrical engineer in order to allow Mr. Hesketh to leave for Australia within the next three months."

Royal Meteorological Society.—At the monthly meeting of the Meteorological Society last Wednesday Mr. W. Ellis, F.R.S., read a paper on the "Mean Amount of Cloud on Each Day of the Year at Greenwich for Fifty Years, up to 1890," from which it appeared that a principal maximum occurs in winter and a principal minimum in autumn, with a secondary much less pronounced maximum in summer, and a secondary minimum in spring. Cloudless days are most numerous in spring and autumn, and least numerous in winter and summer. Days of "much cloud" are nearly equal in amount in all parts of the year. On the same evening Mr. E. D. Fridlander, B.Sc, gave an account of some observations of the amount of dust in the atmosphere made at various places during a voyage round the world in 1894-5. The experiments, which were made with a form of Aitken's pocket dust counter, showed that there are often considerable variations in the number of dust particles in a very short space of time. Dust was found up to an altitude of 6,000ft. or 7,000ft. amongst the Alps, and also in the open ocean so far away from any land as to preclude the possibility of artificial pollution. Major H. E. Rawson, F.R.Met.Soc., also gave an analysis of the Greenwich rainfall records from 1879 to 1890, with special reference to the declination of the sun and moon.

Niagara Electric Tramway.—The Americans are not backward in the provision of means of access to beautiful

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scenery, even if the beauty is not particularly improved in the process. For instance, the current issue of the *Scientific American* contains a description of an electric tramway that has been built along the gorge below Niagara Falls. It is called the Gorge electric railroad, and is worked by the Niagara Falls and Lewiston Railroad Company, and operated in connection with the hotel and observation tower which have been erected by the same company in the village of Niagara Falls, near the State Reservation. The entire length of the road, from Niagara Falls to Lewiston, is about seven miles. Each car has two 50-h.p. Westinghouse motors and electric heaters. The power is now supplied by the Niagara Falls Hydraulic Power and Manufacturing Company, utilising the water from the Schellkopf surface canal at 210ft. head. Two Westinghouse 50-h.p. generators supply the current at 500 volts potential. The line is laid with 60lb. steel rails, double tracked throughout, with trolley wire of 00 gauge. With the exception of the descent from the high land to the river, the maximum grade is 1¼ per cent. The line forms a terrace on the side of the cliff, and is usually about 25ft. above the water-level. Nevertheless, it appears that the spray from the rapids frequently falls on the cars.

The Slide Rule.—We have before us a copy of the second edition of Mr. C. N. Pickworth's excellent little book on the slide rule. This was duly noticed in our columns at the time of its first issue, and therefore nothing more need be said than that the only material alteration in the second edition consists of the rectification of the few errors that have been detected in the work. The form of slide rule dealt with is the Gravêt or Mannheim type, which contains on the front two pairs of logarithmic scales, of which one pair is double of the other, and a metal "cursor," and on the reverse side a scale of equal parts and scales of log. sines and log. tans. When accuracy is not required within 1 per cent. in the result, it is extraordinary the amount of computation that can be done with an instrument of this class. There has always been a fight between the four-figure logarithm table and the slide rule, and in the nature of things it is somewhere about there that the transition from computation by the rule to computation by tables must necessarily take place. It is noteworthy, however, that the disadvantage under which the rule stood for operations involving continuous multiplication has been greatly removed by the adoption of the "cursor," and, indeed, this is one of the marked advantages that this type of rule has over the older forms. The use of rules of this type is extending in this country, though somewhat slowly. There can, however, be no doubt that they only require to be more widely known and better understood to be largely adopted.

Stealing Electricity.—The New Jersey Senate on the 18th ult., by a unanimous vote, passed a Bill to prevent people stealing electric current from the wires. The Bill reads as follows: "Any person who shall unlawfully or maliciously displace, remove, injure, or destroy any line of electric lighting wire or cable, or the material or property belonging thereto, without lawful authority, or who shall unlawfully and wilfully cut, break, tap, or make connection with any electric lighting line or cable, or who shall aid, agree with, employ, or conspire with any person or persons to unlawfully do or permit or cause to be done any of the acts hereinbefore mentioned, shall be deemed guilty of a misdemeanour, and on conviction thereof shall be punished by a fine not exceeding 500dol. or imprisonment at hard labour or otherwise not exceeding two years, or both. Any person who shall wilfully, with intent to injure or defraud, connect a wire or other instrument or contrivance with a wire used for conducting or supplying electricity in such a manner as to supply such electricity to any lamp wherein the same can be lighted or used without passing through the meter or instrument provided for registering the quantity consumed, or who shall wilfully, with intent to defraud, obstruct, alter, injure, or prevent the action of any meter or other instrument used to measure or register the quantity of electricity consumed in a house, shall be guilty of a misdemeanour, and on conviction thereof shall be punished by a fine not exceeding 500dol. or imprisonment at hard labour or otherwise not exceeding two years, or both."

The General Electric and Westinghouse Combination. — We have in a previous number given particulars of the mutual arrangement entered into by the General Electric Company and the Westinghouse Electric and Manufacturing Company in America. The matter has naturally occupied the attention of the technical Press, and the comments upon it are not on the whole unfavourable to the combination. For example, the New York *Electrical Review* says on the subject that "at the first glance this arrangement is liable to impress the small manufacturer in the electrical field as an attempt to form a trust to which he is not a party and which will eventually drive him out of the business. Assuming as true the statement that there is no consolidation of the two companies, and we so believe, the patent basis on which the deal is formed certainly makes them a very powerful competitor of every other manufacturer in the field. No doubt there will be a few of the smaller manufacturers who will find it impossible to compete against such power, but we predict that those who fall by the wayside will not be the companies who have been doing business on business principles, even if only in a small way. In the long run we believe this agreement will be a good thing for the whole industry. It is impossible for any one company or any two companies to secure all the business, or even the lion's share of it. The growth is too rapid and competition is too keen for this to be done. We believe that the small manufacturer who has been doing business on business principles will not only not be disturbed in his work, but will also profit through having a number of unstable competitors cut off, who will find it impossible to compete where he, as a business man, can compete and make money even against the alliance the General Electric and Westinghouse Companies have made." The argument is not quite clear, but the feeling is evident.

Alternating Systems.—Mr. Ernest Scott does not like alternating systems and has written to the *Leeds Mercury* to say so. He does not "envy anyone the position of assistant in an alternating-current station, such as the City of London Company's station at Bankside," and thinks that there must be "something radically wrong about a system which is not supplied with some method of storing the energy required." Continuous-current stations, he adds, "such as St. Pancras, St. James's and Pall Mall, Westminster, Hull, Bradford, etc., are all fitted with accumulators, which automatically take up the change in the load, and the plant generally is more reliable, to say nothing of a minimum risk to life." Mr. Scott then continues: "In a paper which my partner, Mr. Addenbrooke, read before the Institution of Electrical Engineers a few weeks ago it was shown that with the high-voltage lamps (220 volts) which are now on the market, the economical area of supply with continuous currents can be extended from 1½ miles square to five miles square. Now, a square which is five miles along each side will more than cover the area of our largest towns. Another interesting fact is that, owing to patents expiring and increased competition, the manufacture of accumulators has been greatly improved,

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whilst the cost per horse-power has come down within the last five years (50 per cent.) to about the same as ordinary plant—engines, boilers, dynamos, etc. It seems to me, therefore, that those gentlemen who have been and are advising towns to go in for alternating-current supply are likely to find themselves in the wrong box, especially so when we consider the demand for electric motors which is bound to take place in a year or so. For long-distance transmission there is, of course, a large field for alternating currents, only in that case it will have to take the form of two or three phase currents (in order to give a sufficient torque to the motors), and not single phase, as is in use at Leeds, Sheffield, Burton, etc."

Motors for Factory Work.—Commenting on an article by Mr. W. Baxter on the subject of driving machine tools in factories by electric motors rather than by shafting, the New York *Electrical World* says in factory management the cost of production must be reduced to a minimum and the adoption of newer and more expedient methods must constantly be studied. In the case of factories already in operation, the question of discarding long lines of shafting and directly applying motors to the individual units is a serious problem, to which no general statements or conclusions are applicable. "There, are, however, in most factories many points in common, and to these cases more or less general statements can be made. For instance, there can be no question as to the advisability of directly applying motors to large machine tools where current is available, or where several such units distributed about a factory warrant the installation of a generator; or, in case the buildings are separated, to transmit power electrically from a central point. As soon as this is decided, the question immediately arises as to what shall be the minimum size of motor used and to what extent shall individual tools be individually supplied. A study of the particular conditions presented in each factory can alone decide this problem, for it can be stated with certainty that the use of a number of extremely small motors will, in general, not be advisable owing to their inefficiency, increased cost per unit of output, and greater liability to damage. Cases can be imagined where the use of such might to some extent be warranted, yet the question would still arise whether a general grouping driven from one or more countershafts would not be more expedient." A more important point than this would seem to be whether the tools run constantly or only occasionally as required, since the economy of the electric motor comes in from the fact that the load ceases when the tool stops, while the shafting keeps running. Mr. Baxter, however, considers that the use of motors in factories has but just begun, and the future promises an extensive increase in their direct application to machine tools.

Rontgen Radiations.—Mr. H. Becquerel has communicated to the Paris Académie des Sciences some experiments on the difference between the invisible radiations emitted by uranium salts and the Röntgen rays. The former suffer double refraction and polarisation. Messrs. Benoit and Hurmuzescu also stated that the effect of the new radiations in discharging an insulated metal plate varies according to the metal of which the plate is composed. The same is the case with the ultra-violet rays, but the order of the metals is not the same in the two instances. Messrs. Abel Buguet and Albert Gascard state that the Röntgen radiations will at once distinguish between ruby, sapphire, emerald, topaz, and cats-eyes, and their glass imitations. Turquoise is similarly distinguishable, and the curious organic salt of aluminium, mellite, is nearly, as transparent as carbon. In fact, the comparative transparency of metallic aluminium to the Röntgen rays seems to be preserved in all its salts. The doings of Mr. Edison are written about in such a strange way that care has to be exercised in reproducing anything relating to his work from the American Press. One of his undoubted discoveries is, however, that calcium tungstate forms a good fluorescing substance to use for making the new rays visible. It may not be so good as potassium platino-cyanide, but it is very much cheaper, and is preferable for other reasons. But it seems from a letter sent by Mr. T. E. Espin, F.R.A.S., not to a technical paper, but to the *Newcastle Daily Chronicle*, the effect is not quite the same. "Photographing pieces of zinc, tinfoil, and silver with a screen of calcium tungstate before the plate the rays are shown to have penetrated them. With a screen of barium platino-cyanide the images appear." This result is worth further investigation, as if confirmed—and there is no antecedent improbability in it—it points to the existence of something equivalent to undulations of different periods being contained in the Röntgen rays. Nothing further has been heard from the owners of the mysterious plate-box which has special properties in connection with these radiations. Their experiences are doubtless reserved for the next issue of *Knowledge*. As for the theory of the subject it will be time enough to go into that when something definite has been determined. At present it will be sufficient to caution readers against accepting statements that the Röntgen rays cannot be infra-red or ultra-violet radiations because their properties are not the same. All the properties that have been investigated relate to radiations which lie comparatively close to the visible spectrum, and would probably be quite different when the dimensions of the wave become extreme in either direction. It is obvious, for instance, that when the wave is no longer large compared to the atom that a very different state of things will prevail.

Institution of Civil Engineers.—Sir Benjamin Baker presided at the dinner of the Institution of Civil Engineers held on Tuesday in the Queen's Hall. There were a very large number of members of the institution and guests present, including the American Ambassador, the Duke of Teck, Mr. Goschen, M.P., Sir Redvers Buller, Lord Medway, Lord Balfour of Burleigh, Mr. Shaw-Lefevre, M.P., Mr. Bryce, M.P., Sir A. Arnold, Mr. Courtney, M.P., Sir F. Abel, Major-General Sir Charles Wilson, Sir G. Molesworth, Sir E. H. Carbutt, Sir M. Ommaney, Sir D. Galton, Mr. A. J. Barry, Mr. J. W. Barry, Sir Lowthian Bell, Mr. Brunel, Mr. H. Brunlees, Mr. J. Brunlees, Lord Colville of Culross, Prof. Dewar, Mr. Grierson, Mr. Hawkshaw, Mr. Woods, Mr. Maudslay, Mr. Pember, Mr. Pope, Mr. Preece, Mr. Siemens, and others. Mr. Goschen, in replying to the toast of "The Army, Navy, and Auxiliary Forces," said at this moment in every assembly of Englishmen the toast of "The Navy" was received with almost unusual enthusiasm. He took no narrow view of the great profession to which his hosts belonged, for it rested with them to lay down the lines on which civilisation was to advance in various parts of the world. Every great undertaking of this country was associated with engineering enterprise, and it was the engineers who were opening out to the influences of civilisation the continent of Africa. For the navy the work of the engineer was one of paramount consideration. He had no remorse on account of the enormous demands which he had felt it his duty to make on the present Chancellor of the Exchequer, and he was not sorry that of the vast sums which the House of Commons had cheerfully voted for the navy no inconsiderable portion would flow into the coffers of members of the Institution of Civil Engineers. He

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saw amongst them those who made the gigantic armour-plates which protected our ships, those who made the guns and the machinery of our great vessels of war, and those who were mainly responsible for the new class of torpedo-boat destroyers which played so considerable a part in the naval construction of the day. Engineers had done and would do much for the navy, but every invention made that which existed obsolete—and obsolete was a terrible word. There were certain things, however, which did not become obsolete—the courage, the energy, the foresight of the men who manned our ships. The inventiveness, not only of Englishmen, but of others, sometimes placed the Admiralty upon the horns of a dilemma. The Admiralty was sometimes reproached with being unwilling to accept improvements, and sometimes denounced for accepting new inventions too rapidly. Many civil engineers would have been interested in the great controverted question of water-tube boilers. He ventured to think that the experience of foreign countries had shown that this was an invention which deserved the best consideration of the Admiralty. One of the leading features of modern naval programmes was the new class of torpedo-boat destroyers. These had been built by English enterprise and English skill, and were considered to have a great success at the Admiralty, and had achieved the astonishing speed of 29 to 30 knots. Such an invention as this was not to be laid up in cotton wool. It was the duty of the Admiralty to test by experiment, and they were training as many men as they could to try these boats which could accomplish the distance between Holyhead and Dublin in an hour and 50 minutes—about half the usual time. He envied the science of the engineers who were able by experiment to test principles, whereas the politician could never tell whether a measure would be successful or not. The politician attempted to apply a principle, but he could never gauge the result or discover whether his experiment was successful or not. The foundations might be insecure, and the building tumble down, and no one know the cause of the failure. It was the same with economic science, and oftentimes it was impossible to say whether the material of the attempted structure was bad or its original foundation insecure. But the engineer could always follow the application of his theory and test it by the result of experiment. Our statesmen had but one consolation, and that was that our rivals on the Continent were in precisely the same condition as ourselves. Subsequently, Lord Balfour replied for the "House of Lords" and Mr. Courtney for the "House of Commons," and the American Ambassador responded to the toast of "Our Guests," while Mr. Bryce proposed "The Institution," to which Sir Benjamin Baker (the president) made due acknowledgment.

The Metric System.—The articles in the *Times* on the metric system which we referred to last week have naturally called forth a correspondence on the subject. Little new, however, has been said. Either people are weary of the question or the matter has been already thoroughly threshed out and it only remains to take a decision. Mr. Samuel Montague, the president of the New Decimal Society, naturally writes in support of the object of his association. One point made is that while some of the opponents of the metric system object that it would prevent the use of quarters, others complain that they actually are used in the United States, where the decimal system is adopted for money. Mr. Montague admits that "if the whole world could start afresh, a perfect duodecimal system might be universally adopted, but nature, in giving us 10 fingers instead of 12, decided long ago in favour of decimals," and while the advocates of a duodecimal scale are "dreaming about an arithmetical millennium, if that decimal term can be applied appropriately, we are suffering loss and inconvenience at home and abroad." Mr. Emerson Dowson, the chairman of the Executive Committee, repeats the well-known arguments in favour of the adoption of the system. Mr. Robert Kaye Gray, having apparently never heard of the "metric ton" of 2,204lb., objects that "as the greatest weight mentioned in the metric system is the myriagramme of approximately 22lb., this system is unserviceable for dealings in large weights," such as a truckload of coal. Lord Grimthorpe can generally be depended upon to say something vigorous in a controversy of this kind. He remarks that anything beyond making the metric system "lawful for any persons who like to buy and sell or make contracts by it would be a piece of gross tyranny, such as pertinacious prigs sometimes manage to inflict on an enormous majority who are too lazy to fight them, or do not understand what they are doing. The metre never made any way even its native country till that breed of men forced it down the public throat. Just now some commercial ones want to do it in order to save themselves trouble in dealing with metrified countries, and do not care how much they give to everybody else." Lord Grimthorpe, however, will have nothing to do with duodecimals. "The duodecimal system is only fit to go on being set as a mathematical question, as it used to be 60 years ago, in spite of some theoretical advantages. If the founders of arithmetic had been Goliaths with 12 fingers, probably we should have had it." Mr. J. C. Stevenson says that "surely it is far-fetched remedy for the want of enterprise of our foreign traders that all our home traders and the whole internal trade of the country, wholesale and retail, should be compelled to abandon" the old measures. If the measures in use in this country were more uniform, there would be much force in this. His other objection is a sentimental one—namely, the disuse of the English names of weights and measures, those "grand old Saxon monosyllables, which are as old as the English language and the inheritance of the Anglo-Saxon race throughout the world." Some of them are not "Anglo-Saxon," but that does not much matter for the purposes of the argument. Mr. C. Harpur says that "the use of sixteenths and thirty-seconds in Stock Exchange quotations and rupee rates is not an argument against decimalism, but merely an illustration of the fact that the ordinary man only looks as far as the end of his own nose. Halving and quartering is simpler than dividing into tenths, so most people take the former way, forgetting that it leads them inevitably to sixteenths and thirty-seconds. When they reach these latter they wish they had taken the other way. Most people in the City agree that exchange rates would be much easier to work with if expressed decimally; but they do not express them decimally, because no one can start without the consent of all the rest." Lastly, an anonymous correspondent remarks that "it is pretty easy to work out mentally the value of, say, a yard and three-quarters of riband at 3½d. a yard, while it is very difficult to work out mentally the value of, say, 1 metre 75 centimetres of riband at 35 centimes a metre." There is nothing to prevent him working the second problem in the same way as the first if he likes. The fact that the yard is divided into 3ft. has not prevented him using quarters of a yard. Curiously enough, everyone has shirked the question of the division of the angle which is hopelessly mixed up with the measure of time. But the only "practical" man concerned in this matter is the sailor, and he settled the matter long ago by using a mile of his own which has no relation to the statute mile.

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THE ROYAL COLLEGE OF SCIENCE.

It was announced on Wednesday that the Lord President of the Council had appointed Prof. J. Perry to the

PROF. PERRY.

vacant Chair of Mechanics and Mathematics at the Royal College of Science.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXVII.

(Specially Contributed.)

THE INDUCTION OF CURRENTS BY MOTION OF MAGNETS—NOTIONS ABOUT MAGNETIC LINES OF FORCE—MAGNETO-GENERATORS FOR ELECTRIC BELLS—SIMPLE DESCRIPTIVE KNOWLEDGE OF THE COMMON SORTS OF DYNAMOS AND ALTERNATORS.

Faraday's Paper of November 21, 1831.—Two names of departed physicists have always occupied a place in my mind, which would indicate me a thorough-going hero worshipper. These names are those of Faraday and Tyndall. I was never much of a biologist, hence Huxley is not to me so great a hero as the men I have named. Faraday's researches must always possess a fascination for students of electrical science, and Tyndall's "Heat a Mode of Motion" was a revelation to me as a young student, and the interest excited by its study was afterwards largely increased by hearing the voice and seeing the experiments of this great teacher. There are living physicists who, to me, ought to be characterised as heroes, but through some mistaken freak of fashion it is not customary to tell your heroes that you admire them as men, writers, or teachers. You must wait to worship till they are dead and cannot be cheered by a knowledge that their labours are appreciated.

Faraday was a physicist in the truest sense of the word. And I feel I cannot do better than to introduce this part of my subject in his own words, given in his memorable paper of November 24, 1831. This paper is divided into four sections: § 1. On the induction of electric current. § 2. On the evolution of electricity from magnetism. § 3. On a new electrical condition of matter. § 4. On Arago's magnetic phenomena. As regards the first section, this forms part of the subject-matter of our next chapter. The second section of the paper, however, is now our study. In it Faraday says:

"A welded ring was made of soft round bar iron, the metal being $\frac{7}{8}$in. in thickness and the ring 6in. in external diameter. Three helices were put round one part of this ring, each containing about 24ft. of copper wire $\frac{1}{20}$in. thick. They were insulated from the wire and each other, and superposed in the manner before described, occupying about 9in. in length upon the ring. They could be used separately or conjointly; the groups may be distinguished by the letter A (Fig. 1). On the other part of the ring about 60ft. of similar copper wire in two pieces were applied in the same manner, forming a helix, B, which had the same common direction with the helices of A, but being separated from it at each extremity by about $\frac{1}{2}$in. of the uncovered iron.

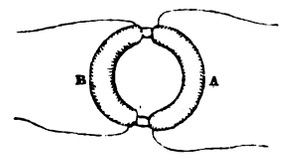

FIG. 1.

"The helix, B, was connected by copper wires with a galvanometer 3ft. from the ring. The helices of A were connected end to end so as to form one common helix, the extremities of which were connected with a battery of 10 pairs of plates 4in. square. The galvanometer was immediately affected . . . but though the contact was continued, the effect was not permanent, for the needle soon came to rest in its natural position, as if quite indifferent to the attached electromagnetic arrangement. Upon breaking the contact with the battery, the needle was again powerfully deflected, but in the contrary direction to that induced in the first instance."

It may be pointed out here that *this simple apparatus of Faraday's was the first transformer* ever made. Further on Faraday says:

"By using charcoal at the ends of the B helix, a minute *spark* could be perceived when the contact of the battery with A was completed."

This was foreshadowing the use of the developed apparatus in the latter years of the century. For historical purposes our next chapter should have come before this, because Faraday shows the difference between the actions of coil on coil with and without the iron core. To return again to Faraday's words:

"Similar effects were then produced by *ordinary magnets*. Thus the hollow helix just described has all its elementary helices connected with the galvanometer by two

FIG. 2.

copper wires, each 5ft. in length; the soft iron cylinder was introduced into its axis; a couple of bar magnets, each 24in. long, were arranged with their opposite poles at one end in contact, so as to resemble a horseshoe magnet, and then contact made between the other poles and the ends of the iron cylinder, so as to convert it for the time into a magnet (Fig. 2); by breaking the magnetic contacts or reversing, the magnetism of the iron cylinder could be destroyed or reversed at pleasure.

"Upon making magnetic contact the needle was deflected. Continuing the contact, the needle became indifferent and resumed its first condition. On breaking the contact it was again deflected, but in the opposite direction to the first effect, and then it again became indifferent. When the magnetic contacts were reversed, the deflections were again reversed.

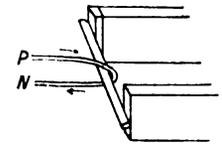

FIG. 3.

"When the magnetic contact was made, the deflection was such as to indicate an induced current of electricity in the opposite direction to that fitted to form a magnet having the same polarity as that really produced by contact with the bar magnets. Thus, when the marked and unmarked poles were placed as in Fig. 3, the current in the helix was in

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the direction represented, P being supposed to be the end of the wire going to the positive pole of the battery, or that end towards which the zinc plates face, and N the negative wire."

Surely we may consider this *the first alternator* ever made.

We may refer to one other description of apparatus in this remarkable paper:

"A disc of copper, 12in. in diameter, and about ⅛in. in thickness, fixed upon a brass axis, was mounted in frames so as to allow of revolution either vertically or horizontally, its edge being at the same time introduced more or less between the magnetic poles" (Fig. 4). . . . The copper

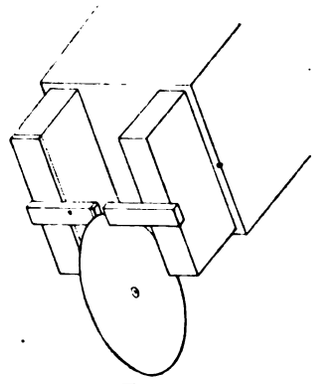

Fig. 4.

disc was adjusted as in Fig. 4, the small magnetic poles being about ½in. apart, and the edge of the plate inserted about half their width between them. One of the galvanometer wires was passed twice or thrice loosely round the brass axis of the plate, and the other attached to a conductor which itself was retained by the hand in contact with the amalgamated edge of the disc at the part immediately between the magnetic poles. Under these circumstances all was quiescent, and the galvanometer exhibited no effect. But the instant the plate moved, the galvanometer was influenced, and by revolving the plate rapidly the needle could be deflected 90deg. or more. . . .

"Here, therefore, was demonstrated the production of a permanent current of electricity by ordinary magnets."

Fig. 5 gives a complete view of Faraday's apparatus, and this was *the first magneto-electric machine* ever made.

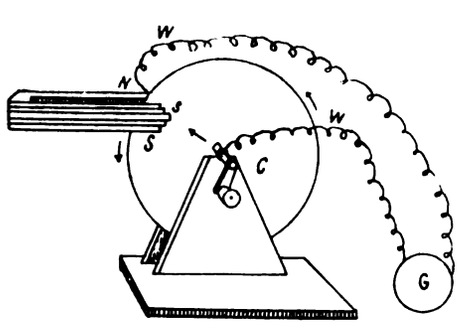

Fig. 5.

Thus Faraday in this one paper broke ground in the applications of electricity which to-day is of overwhelming importance. In the diagram, C shows the copper disc, N S the poles of the permanent magnet. One contact is with the axle of C and the wire of the galvanometer, G. The other contact is with the edge of the disc, C, and the other wire of the galvanometer. When the disc is rotated as shown by the arrows, the current seems to go from the axis to the circumference through wire to galvanometer, and by other wire back to axis, thus completing the circuit.

Pixii.—Faraday's discoveries were soon to bear fruit, and in 1832 Pixii constructed what is usually termed the first magneto-electric machine. Fig. 6 shows this apparatus, which consisted of a strong vertical permanent magnet, of horseshoe shape, capable of being rotated by the wheels and spindle shown. A fixed horseshoe electromagnet had its poles just above those of the permanent magnet. As the field magnet rotates, a current is induced in the coil of the electromagnet, and passes to the external circuit by the wires shown. The fixed electromagnet in this case forms the armature of the permanent magnet.

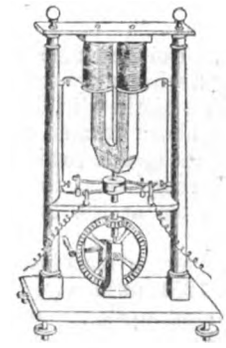

Fig. 6.

Saxton.—Following Pixii, Saxton designed a machine in which the armature rotated while the field magnets remained stationary. Fig. 7 shows the complete machine. Here a compound permanent magnet, A, is fixed in an horizontal position, and as close as possible to the poles an armature consisting of an electromagnet with core of soft iron. The armature is rotated by means of the wheel and strap, F, on to the spindle carrying the armature.

The magnet in Saxton's apparatus was about 7in. long, with a polar air-gap of 2in. In Fig. 7, A is the compound horseshoe magnet, C three insulated helices of copper wire, D a wooden cup containing mercury upon a stand, H. A copper disc, E, dipped into the mercury, and

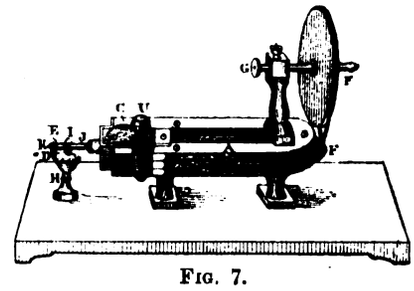

Fig. 7.

was connected to one end of the helices by a brass piece, I. A cross-bar of copper by a screw, J, was connected to the other end of the helices, and was so adjusted that when the revolving armature was at right angles to the magnet poles the ascending point of the cross-bar was about $\frac{1}{20}$in. above the surface of the mercury. The rotation was caused by the wheel and band, F F. The position of the wheel was regulated by the screw G, and thus the band tightened or not as required.

Miller gives the following description of one armature details (Fig. 8): It "consists of two straight pieces of iron

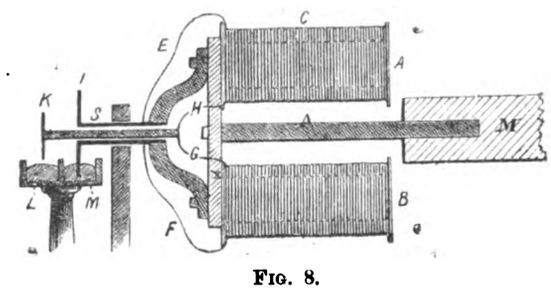

Fig. 8.

about 2in. in length, which, by means of a cross-piece of iron (the yoke, X), are connected together parallel to each other at such a distance that they shall be opposite the middle of each pole of the horseshoe magnet. Around each limb, C D, of the armature a long fine copper wire covered with silk, to insulate the coils from each other, is wound in several successive layers. The corresponding ends of each of these helices are connected together; one pair, E F, is soldered to the spindle, S, on which the armature rotates, and through it is connected with a circular copper disc, I, the edge of which dips into a cup of mercury, M, whilst

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the other pair of wires, G H, is connected with a stout piece of copper which passes through the axis of the spindle, S, from which it is electrically insulated, and terminates in a slip of copper, K, placed nearly at right angles to the yoke, X, which connects the two limbs of the soft-iron armature. Beneath the slip of copper, L, is a second mercury-cup, N, which can be made to communicate with the cup M, either by a wire or by some other conductor of the current. The arms of the slip, L, alternately dip into the mercury and rise above it, and the points of contact are so arranged that the circuit (which when N and M are properly connected is complete so long as L is beneath the mercury) shall be broken at the time that the armature loses its magnetism."

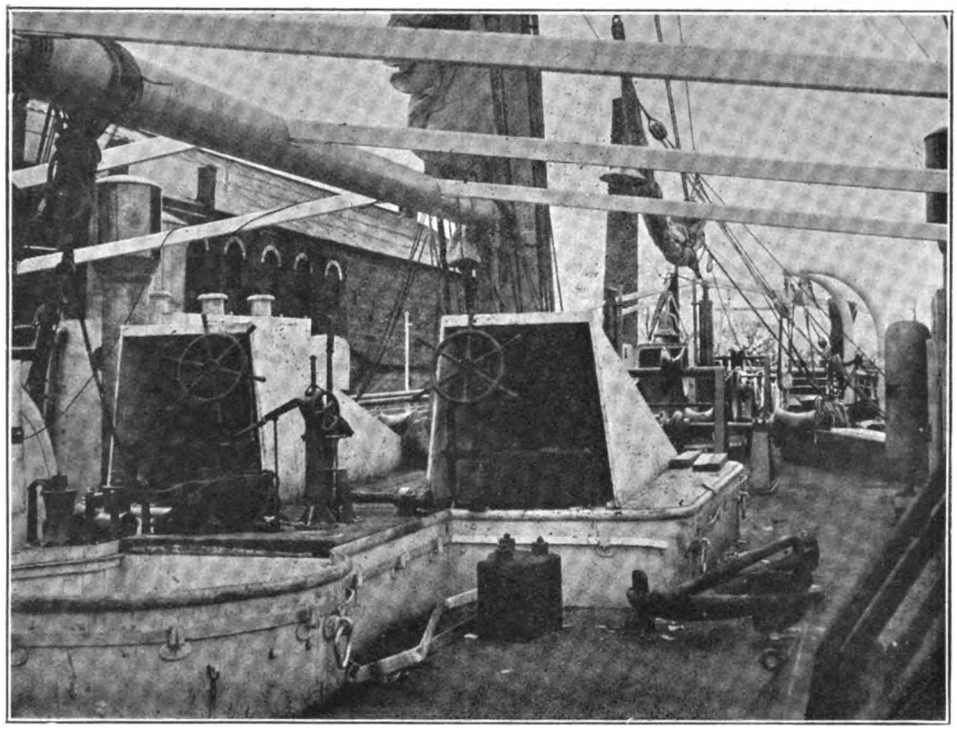
Numbers of these magneto machines were designed from the time of Faraday, 1831, until, say, about the year 1880; but as soon as electrical work entered into what may be termed the engineering stage they had to give place to a different type of machine, till now they are used to any extent only in electric bellwork.

DESCRIPTION OF GEAR FOR JAPANESE SUBMARINE CABLE STEAMER.

A few months ago the Japanese Government, as represented by their Glasgow consul (Mr. A. R. Brown), entrusted Messrs. Johnson and Phillips with the construction of a combined picking-up and paying-out gear, together with outfit and stores for their new submarine cable-laying vessel, of which the following is a description. The gear, as shown in the photographs which we reproduce, is very compact, and has been constructed principally of steel so as to combine strength with lightness, the weight all told being only about 21 tons. Although specified to pick up under a strain of 25 tons at 175lb. pressure, the gear on official trial showed itself equal to a much greater pressure compared with the gear by the same makers fitted on the "John Pender," "Great Northern," "Chiltern," "Electra," "Magneta," "Recorder," "Relay," "Cita de Milano," and many other steamers; it is equally powerful as the three first-named, and twice as powerful as the others, while at the same time it is infinitely more compact and lighter than any that have gone before.

The gear stands on a strong steel girder bed on the main deck, and the drums, etc., project through a hatch in the spar deck, and this is fitted with covers which form the driving platform for the machine. The gear has overhung drums, 6ft. 3in. diameter by 2ft. 6in. wide, internally geared and running loose on a fixed shaft carried on two steel frames, and is arranged for four speeds. The motive power consists of one vertical compound engine, having cylinders 12in. and 24in. diameter by 14in. stroke, capable of developing 265 h.p. without the use of the condenser, in conjunction with which it will, however, generally be used. The engine is fitted with link motion reversing gear, and also with automatic by-pass valve for admitting high-pressure steam to low-pressure cylinder for starting. The crankshaft is geared to the first motion shaft of the machine by means of double helical bevel gear. When it is desired to pay out without steam power, the only moving portion of the machine is the drum, which is readily controlled by the brake. To enable the drum to revolve independently of any other part of the gearing, provision had to be made for sliding the drum pinions out of gear, and as it was essential to keep the drums close up to the frames, these pinions have been arranged to draw through the frames. This has been effected in a very neat manner by the makers, two large holes being cut in the frame plates and a large pocket casting fitting into these carrying bearings each side of the frames, so that the pinions which gear into drums run between two bearings, the arms of the drum being set back to allow for this outer bearing. These pinions are put into and out of gear by means of a combination of hand-wheels, screws, and bell-crank levers. All wheels are arranged to draw out of gear when necessary, so that only the particular set required needs to be in gear. The brake straps are of steel plate fitted with elm blocks. The lower parts of the straps have large cast-iron eyes attached to them, and these are kept in position by means of a shaft 3½in. diameter, which passes through both frames. The braking power is applied by means of right and left hand screws working in nuts attached to the upper parts of the straps, the screws being actuated by means of hand-wheels from the starting platform, and when the straps grip the brake drum the pull is transmitted to the machine frames through the before-mentioned eyes and shaft, and thus to the deck of the vessel. A water service is provided for the brakes, the water being distributed by means of a small Worthington pump. Each drum is provided with two "knives" for fleeting the cable on the drums to suit either an inside or outside lead, as the case may be.

There are three sheaves at the bows, 51in. diameter by 11in. wide, the two outer ones being V section and the middle one U section. These sheaves are of steel, with



Cable Gear, by Messrs. Johnson and Phillips.

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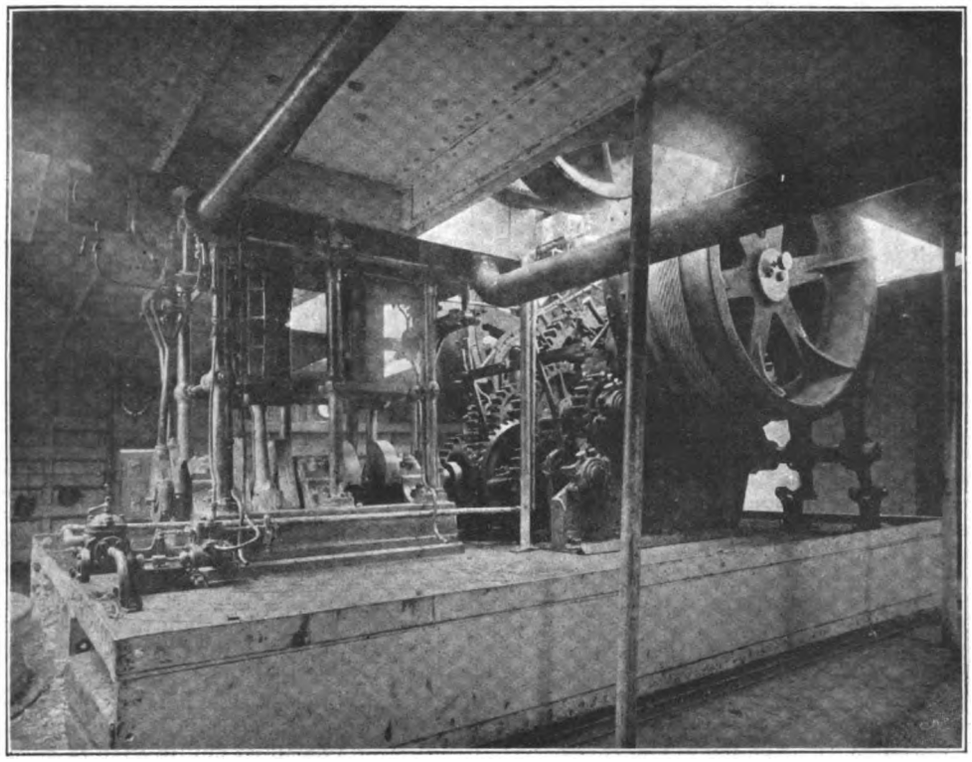
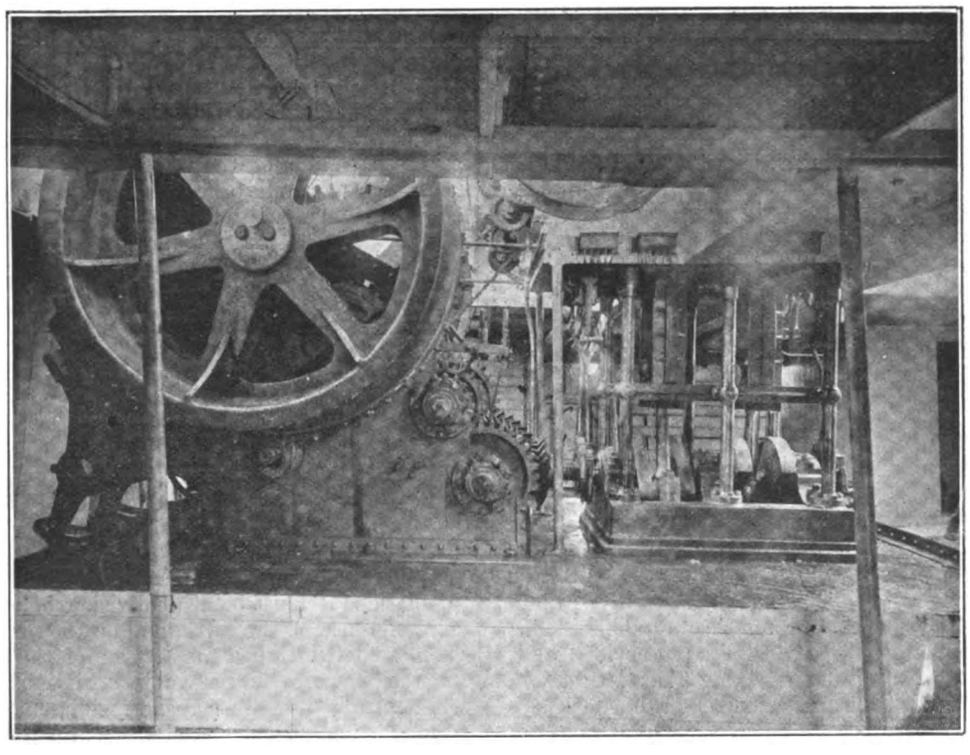
gunmetal bushes, and they are arranged to run loose on a steel shaft fixed in blocks carried on four steel girders, which are built into the ship for a distance of several feet, being connected to the beams and to the steel deck. Each sheave is provided with a cast-iron "whisker," or guard, at each side to prevent the cable from coming off. The two outer whiskers carry davits with a cross-bar for convenience in launching mushrooms, grapnels, etc. The side plating of the ship is carried out to meet these castings, thus giving the bows a very neat appearance.

The stern gear has but one sheave, which is 38½in. diameter by 11½in. wide, and is fitted with gunmetal liner to run loose on a shaft fixed on blocks carried by rolled girders. These girders are attached to the deck by means of special castings, which also serve to secure the necessary stopper hooks.

The cable machine is placed just aft of the foremast, and between it and the bow sheaves are placed the two dynamometers (one for each drum) for the purpose of registering the strains that come upon the cables or grapnel ropes. To effect this, a set of leads consisting of A frames and sheaves is placed at a certain distance on each side of the dynamometer, so that when a strain comes upon a cable or rope the moving part of the dynamometer is raised, the distance raised being in measure of the strain according to the weight of the moving part.



Cable Gear by Messrs. Johnson and Phillips.



Cable Gear by Messrs. Johnson and Phillips.

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The dynamometers are of Messrs. Johnson and Phillips's approved design, consisting of cast-iron footstep with steel cylinders, on which a large cast-iron sleeve slides, and to this sleeve the sheave is attached, and also two side rods which carry a cross-head some distance above. To the cross-head is attached a piston-rod with piston, which works on the outside of the steel cylinder, which is filled with oil, and the piston being a loose fit this acts as a dash-pot to steady the movement. The top of the steel cylinder is, of course, fitted with a packed gland.

SUGGESTIONS FOR A DUODECIMAL SYSTEM OF NOTATION, WEIGHTS, AND MEASURES.

BY G. HALLIDAY.

[Some years ago the following article was sent us, but the time for its use seemed inopportune, though in a measure we agreed with the author's condemnation of the metric system. Incidentally Prof. Lodge, during one of the discussions at the last meeting of the British Association, uttered an emphatic protest against the adoption of the metric system; at any rate, his words conveyed that meaning to us. Mr. E. L. Garbett, many years ago, if our recollection serves us, put the arguments against the French decimalism system into a pamphlet. More recently the *Times* has inserted a series of articles and a number of letters on the subject, so that we think the time is ripe for a little elementary information for general readers—for those, in fact, who do not quite understand the different systems so often referred to by various writers.—ED. *E. E.*]

The younger race of engineers who deal with measurable quantities and working-men have for some considerable time held that the praise poured forth on the metric system, and consequently on our base of notation, is, to say the least of it, rather out of place. One cannot certainly say much against the advantages of man being endowed with 10 fingers, that he has exactly 10, not more or less; but one does not expect him to go into ecstasies over the matter and get on the stump and declare that he has 10 day after day with fearful iteration for all time: least of all does one expect that those who have the honour of being what are commonly known as mathematicians and scientific men should also begin to boast of their ability to count 10 and to glory in the genius they had displayed by selecting this number 10 as the base of all their calculations just because they happened to have 10 fingers. Under certain conditions this number could not very well be improved upon. For example, in a country where savages exist it might be found convenient for assisting one of them to understand what you mean by such a number as 15 to hold up both hands with the fingers spread out, lower them, and then hold up one hand spread out as before. Elsewhere, however, and especially where the people make some pretensions to learning, and more especially where a section of the people have considerable mathematical knowledge, we might expect something better than the "convenience-of-savages" argument given as a reason for the continuance of the base 10. Nor will it do to argue for its continuance because of its antiquity. This is no very special argument in its favour, for the Welsh count by fives and scores, and have done so for no mean length of time, and yet there exists no Englishman who does not think that they should give up their own system and adopt his—nor does he hesitate to enforce them to do so. Speaking mathematically, I do not think that anything which has not been established on a sound and mathematical basis deserves preserving: and I will now give my reasons for thinking that 10 does not deserve to be preserved as a base, and I shall show which other number would serve most conveniently as a base of notation, weights, and measures.

Our English unit of length is the distance between two scratches on two gold plugs sunk in and near the ends of a bronze bar. This distance is not connected with any physical measurement, for Parliament in quite an arbitrary way settled that this physically unconnected distance marked out on the bronze bar was in future to be considered by the English people as their unit of length. Should any injury be done the bar, by fire or otherwise, the machinery of Parliament would again have to be set agoing to enact that another distance, or, accidentally, the same distance, should after that time be recognised as the unit of length.

Neither has this unit the yard been happily chosen to facilitate calculations. Especially is this the case as regards its multiples; one of them being actually the number $5\frac{1}{2}$. In fact, they could not possibly be more crudely taken. They are quite systemless, and this is so much the case that English scientific men have entirely discarded the unit and adopted the metric system in its place. Indeed, were it not for the sub-division disadvantages of the metric system, engineers and others connected more closely with measurable quantities would have taken the advice of the great gauge engineer, Whitworth, and adopted it long ago. But it no way appeals to the practical man's innate sense of division. He likes to divide things into pairs or threes. And then, again, the decimal system is so cumbrous. Fancy our old familiar $\frac{1}{16}$th of an inch being measured by such uncouth figures as ·0625! Even Whitworth, with all his courage, must have had misgivings when recommending such a number to the select of practical Englishmen in place of the old, better, and familiar $\frac{1}{32}$. Sub-division under the metric system has not been a success, and Whitworth failed to establish it as a part of our engineering practice. He did all he could for it, however, for on the gauges which his firm supplied to other engineering firms he caused to be marked the decimal equivalents of the $\frac{1}{8}$ths and $\frac{1}{16}$ths, etc. No mechanic reads them, and although for purposes of calculation the English scientific man has adopted the metric system, the practical working-man sticks to the old foot with all its needful sub-divisions of inch and line, and in spite of all its multiple faults.

Of all working-men, the Englishman is, perhaps, the most sensible, the most practical, and when we examine the unit which the English sailor takes we find that for his purposes it could not be better. For facilitating calculation it is necessary that the sailor should have his unit in some way connected with the earth's circumference, and this he has just done, for his unit of length is the length of the arc on the equator subtending an angle of one minute at the centre of the earth. The yard does not pretend to be connected with the length of the circumference of the earth or with the length of the arc of any angle made with any radius, and so it does not specially appeal to the sailor for its adoption by him; and the metre, though closely connected with the circumference of the earth, and consequently with the division of the right angle, 90deg., is so helpless in the number and particular sub-divisions and multiples of the angle and of distances that it also does not specially appeal for its adoption. Neither system has appealed to him, and his practical reason has led him to reject both.

Some time ago an enterprising weekly science journal sent out circulars requesting information with respect to the different kinds of gauges and scales used in this country. Although it has not yet transpired what practical use they intend to make of the information so obtained, there is no doubt that when they place the matter into the hands of some practical man, as they are sure to do, he will recommend a unit of length which will satisfy the requirements of the sailor and the engineer, and connect it with a system of numbers made up on a base which will satisfy the most fastidious calculator. For the purposes of the sailor's calculations it must be a sub-division of the length of the circumference of the earth, and on the same system an arc of an angle which is a sub-division of the right angle. And for the purposes of the engineer it must be sub-divided and multiplied by a number which admits of the highest form of sub-division. And, lastly, for the purposes of the calculator, a new notation must be got out, and the base of that notation must be that number which is found for sub-division purposes most suitable to the engineer. For reference purposes it must also be a sub-division or multiple of a constant indestructible physical length.

Now, there are many things which would suit one of them best, but we must have one which, though it may not suit each best, will suit all very well; and the number so

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chosen must commend itself to the mechanic in the very first place.

Now, the number which appears to be the greatest favourite with working-men for the purposes of sub-division is the number 12. The engineer has adopted it for the division of the foot into inches, and all the spaces which the compositor employs are also fractions of 12; the sub-division of the shilling is 12, and the zodiac has been divided into 12 equal parts. Ten only admits of division into halves and fifths, while 12 may be halved, and each half again halved, and it can be divided into three equal parts and each of these again halved. Indeed, of all our small convenient numbers, 12 lends itself best to the process of sub-division.

The adoption of the number 12 for the purposes of sub-division and multiplication of our units would necessitate the adoption of the number 12 instead of the number 10 as a base for our system of numbers; for we must be able to read off our answers by the mere placing of the decimal point just as we do when using the metric system.

The use of 12 as a base of our system of notation will be best explained by taking an example. Take the figures 59. Under our present system they mean nine units added to five times 10; but under the proposed new system, which has 12 for a base, the figures would mean nine units and five times 12, what we at present call 69, the number 5 having a value, in virtue of its position, greater, however, in the latter system than under the former. So, under the present system, the figures 8,972 have the meaning shown below:

Two	stands for 2 units	2×1	=	2
Seven	,, 7 tens	7×10	=	70
Nine	,, 9 hundreds	$9 \times 10 \times 10$	=	900
Eight	,, 8 thousands	$8 \times 10 \times 10 \times 10$	=	8,000
				8,972

But under the new system, with its higher base, 12, the figures would mean

Two	stands for 2 units	2×1	=	2
Seven	,, 7 twelves	7×12	=	7×12
Nine	,, 9 (twelves)^2	$9 \times 12 \times 12$	=	$9 \times 12 \times 12$
Eight	,, 8 (twelves)^3	$8 \times 12 \times 12 \times 12$	=	$8 \times 12 \times 12 \times 12$

or, $8 \times 12^3 + 9 \times 12^2 + 7 \times 12 + 2$.

And this is still to be represented by the figures 8,972. To do this some changes must be introduced into our manner of counting units. Under the present system, which has the number 10 for a base, we count up to the number 9 before we begin to represent the number with two or more characters, but under the new we would count up to 11 before we begin to represent numbers with two characters. Under the present system 10 is represented by 10, under the new 12 must be represented by 10, and 10 and 11, which at present are represented by double characters, will under the new system be represented by single characters.

Mr. E. Lonsley, instructor of mathematics in the Royal College of Science, Dublin, has suggested then 10 should be represented by an Old English 6 laid on its face, as shown (ϭ), and 11 by the same figure laid on its back, as shown (ϭ).

The numbers up to 12 will then be represented by the following characters:

1	2	3	4	5	6	7	8	9	ϭ	ϭ	10
one	two	three	four	five	six	seven	eight	nine	ten	eleven	twelve,

and higher than 12 and up to 24:

11	12	13	. . .	19	1ϭ	1ϭ	20
firsteen	secondteen	thirteen		nineteen	tenteen	eleventeen	twenty,

and from 132 to 144:

ϭ1	ϭ2	. . .	ϭ9	ϭϭ	ϭϭ	100
eleventy-one	eleventy-two		eleventy-nine	eleventy-ten	eleventy-eleven	hundred.

If we wish to do an addition sum by this system, we have only to remember that we have to carry we must divide by 12 instead of 10 as before. For example, take the following sum:

8,674
5,732
4,565
61,74ϭ

The answer being sixteen thousand seven hundred and forty-eleven.

Below stands a multiplication table made out to a base 12:

1	2	3	4	5	6	7	8	9	ϭ	ϭ	10
2	4	6	8	ϭ	10	12	14	16	18	1ϭ	20
3	6	9	10	13	16	19	20	23	26	29	30
4	8	10	14	18	20	24	28	30	34	38	40
5	ϭ	13	18	21	26	2ϭ	34	39	42	47	50
6	10	16	20	26	30	36	40	46	50	56	60
7	12	19	24	2ϭ	36	41	48	53	5ϭ	65	70
8	14	20	28	34	40	48	54	60	68	74	80
9	16	23	30	39	46	53	60	69	76	83	90
ϭ	18	26	34	42	50	5ϭ	68	76	84	92	ϭ0
ϭ	1ϭ	29	38	47	56	65	74	83	92	ϭ1	ϭ0
10	20	30	40	50	60	70	80	90	ϭ0	ϭ0	100

Sailors, as I said before, have chosen quite naturally the most scientific and rational unit of length, it being such a unit as simplifies their calculations of distances at sea. Their unit is the average length of the arc subtending an angle of a minute at the equator. If the division of angles by the English system were the best, then the mariner's nautical mile—the knot—is the very best practical unit of length; but the division of angles is not the best, for it is not connected with a decimal system of notation; and the French system is even worse, for it does not admit of the even measurement of such very common and important angles as 30deg., 60deg., 75deg., and 15deg.

A change of division of angles to the duodecimal scale will obviate both difficulties. A degree can be taken as one-twelfth of the right angle, a minute as one-twelfth of a degree, and the second as one-twelfth of the minute.

The arc subtending the second measured along the equator can be taken as the mariner's unit of length, which will be, if we take the circumference of the earth at the equator equal to the length of the meridian passing through Paris, just about equal to the old unit, the league, or more exactly, 227,871·6in.

The league, again, may be divided into duodecimal scale in the following way. In doing so, the names given to the lengths representing the sub-divisions may be taken to correspond to the names furlong, yard, foot, etc., or to the French system with such names as duo-decifoot, duo-kilofoot, etc. Taking the former, the table of lengths will stand as under:

TABLE OF LENGTHS.

One line		
Twelve	lines	= 1 inch.
,,	inches	= 1 foot.
,,	feet	= 1 yard.
,,	yards	= 1 pole.
,,	poles	= 1 furlong.
,,	furlongs	= 1 league, or 227,876·6in.

The foot which we might conveniently take as our principal and fundamental unit will, curiously enough, coincide with the foot in our present table of lengths—the length in inches according to the latest determination being 11·996293in.; and if it be remembered that the length of the equator is slightly longer than the meridian through Paris, the new foot may be taken for all practical purposes equal to the old, and therefore involve no very radical change in our present engineering practice.

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Expressed under the new system of notation, our table of lengths will stand thus:

1ft. = 11·996293in.

1 line.
10 lines = 1in.
100 ,, = 10in. = 1ft.
1,000 ,, = 100in. = 10ft. = 1 yard.
10,000 ,, = 1,000in. = 100ft. = 10 yards = 1 pole.
100,000 ,, = 10,000in. = 1,000ft. = 100 yards = 10 poles = 1 furlong.
1,000,000 ,, = 100,000in. = 10,000ft. = 1,000 yards = 100 poles = 10 furlongs = 1 league.
1,000 leagues = quarter of earth's circumference.

For small areas the square inch will be most convenient, and for the measurement of land the square pole might be taken. For small volumes, and for calculating the weights of materials, the cubic inch will be found very convenient. The cubic foot, of course, will contain, under the new system of notation, 1,000 cubic inches.

The best unit of mass will be the quantity of matter which contains the same amount of matter as a cubic inch will contain of distilled water at the maximum density 4deg. C. This might be called a "mass," and the confusion at present existing by calling the units of mass "pressure" and "weight" would be obviated.

The table of measures of mass expressed in the same manner as the French and under the new system of notation would stand thus:

TABLE OF MEASURES OF MASS.

1 duo-milimass.
10 duo-milimasses = 1 duo-centimass.
100 ,, = 10 ,, = 1 duo-decimass.
1,000 ,, = 100 ,, = 10 ,, = 1 mass.
10 masses = 1 decamass.
100 ,, = 10 ,, = 1 hectomass.
1,000 ,, = 100 ,, = 10 ,, = 1 kilomass.
1,000 kilomasses = 1 quatreton.
1 mass weighs ·03612lb.
1 kilomass 62·425lb.
1 quatreton about 4 tons.

There is still another fundamental unit to be brought under the duodecimal system, and that is the unit of time. The unit of time to which all other units of time must be referred is the day, the day being the time taken by the earth to complete one revolution about its own axis. Lately, an attempt was made to get over the difficulty of dividing the day into two parts of 12 hours each, and distinguishing the one set of hours from the other set by affixing the letters a.m. and p.m. The suggestion was to count 24 hours to the day, calling 1 p.m. 13 o'clock and 9 p.m. 21 o'clock. The suggestion has not been received with much favour. If the unit of time is to be connected with the duodecimal system it will be best to divide the day into 12 parts, and make each division equal to two hours. In this way the measurement of time might be arranged as under:

TABLE OF TIME.

1 second
100 seconds = 1 minute
10,000 ,, = 100 minutes = 1 hour
100,000 ,, = 1,000 ,, = 10 hours = 1 day.

The present second is one 86,400th part of the day, and the new second would be one 248,832nd part of the day.

As the price of things should also be found by the mere placing of the decimal point, it will be necessary to make a table of money. The following looks fairly well:

TABLE OF MONEY.

1 penny.
12 pence = 1 shilling.
12 shillings = 1 mark.
12 marks = 1 note.

Or thus:

1 penny.
10 pence = 1 shilling.
100 ,, = 10 shillings = 1 mark.
1,000 ,, = 100 ,, = 10 marks = 1 note.

The units in the duodecimal system which would answer to the units in the centigrade gramme system will be the inch, mass, and second.

The advantages of such a system are not quite apparent at first sight. They, however, may be shown by working out sums by both systems and comparing the amount of work done in both cases. There is another advantage which is not apparent in calculations, and which can be only felt by the engineer and draughtsman—that is, the advantage gained by having a better and wider system of subdivision combined with a decimal system. However, the advantages of the system, as far as calculation is concerned, are sufficiently shown by the two like sums which are worked below. It will be observed that under the new system four different operations are found necessary, and under the present 10 must be made.

Example: A block 9ft. × 4in. × 7ft. and specific gravity = 7 at 3d. per mass; find its value:

9
4
—
3·0
7
—
19000 cubic inches
7
—
103000 masses
3
—
309·000 notes

In the present style this example would stand thus:

A block 9ft. × 4in. × 7ft. and specific gravity = 7 at 3d. per pound; find its value:

9
4
—
3·0
7
—
21, cubic feet.
7
—
147
62·5
—
735
294
882
—
9,187·5lb.
3
—
12)27,562·5d.
—
2,0)229,6·8s.
—
£114. 16s. 10d.

The above are only suggestions, and I think they at least sufficiently show that no very radical change is necessary for the adoption of such a system of notation, weights, and measures as far as the engineer is concerned.

Niagara Falls.—The *Western Electrician* states that when the third generator now being erected in the central power station of the Niagara Falls Power Company is completed, the total power product there will be 15,000 h.p. It is, however, stated that as many as seven more dynamos have been contemplated, but nothing is at present decided as to their erection.

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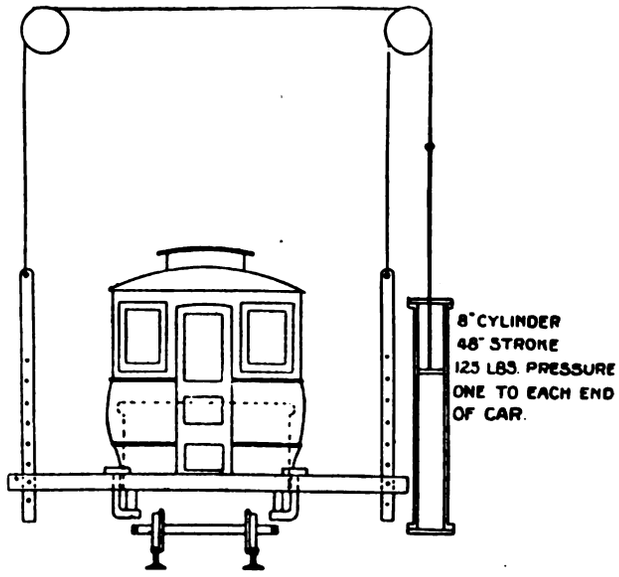
HYDRAULIC HOIST FOR CAR BODIES.

Of the many handy schemes for hoisting car bodies that we have seen and which have been described in the columns of the *Street Railway Review*, one of the best is that put in by Thomas Elliott, chief engineer of the Atlanta Consolidated. The plan of the arrangement is shown in the accompanying diagram. It is a hydraulic hoist with two 8in. cylinders 48in. long, standing on end, and bolted to the floor. Cables



Hydraulic Hoist at Atlanta.

run from the pistons over pulleys overhead. Water at 125lb. from the boiler feed pump is employed for operating the hoist as only a small amount is used.

INSTITUTION OF ELECTRICAL ENGINEERS, April 16.

SIR HENRY MANCE in the chair.

At last night's meeting of the Institution the following candidates were balloted for:

Associates.—Stanley J. Goddard, the National Telephone Company, Oxford-court, Cannon street, London; William Johnson, the National Telephone Company, Sheffield; Walter Victor Morten, the National Telephone Company. Oxford-court, Cannon-street, London; Robert Ellis Shawcross, 66, Lexham-gardens, W.; Arnold Turner, Denton, near Manchester; Ernest Anthony Max Winter, 53, Charterhouse-street, E.C.

Students.—Edward Nugent Bankes, Arc Works, Chelmsford; Sidney John Clay, 11, Scarborough-road, Finsbury Park, N.; Benjamin Shuttleworth Hornby, 2, Hilda-road, Mostyn-road, Brixton; Charles H. Rosoman, Holder's-hill, Hendon, N.W.; Ralph Rushton, jun., Bernard Sankey, Percy Cunliffe Simpson, and William George Stuart, Faraday House, Charing Cross-road, W.C.; Frank Triste Wordley, 235, Burrage-road, Plumstead.

After the usual business, the discussion on Mr. Dane Sinclair's paper, "Telephone Exchanges and their Working," was proceeded with.

Mr. Kingsbury said, before he discussed the paper, he would like to call attention to the fact that Mr. Sinclair brought forward two rather important questions with a view of improving the local service, and, to some extent, to reduce its cost. Those were two points on which it was impossible to hold other than one opinion, and they must all be in accord with Mr. Sinclair in his aims, but it was open to some of them to feel that there were other ways of obtaining those results, and they might even go so far as to remark that in his methods he did not obtain the results he aimed at. In reference to the call-wire system, Mr. Kingsbury quoted from a speech delivered in that room by Sir Frederick Bramwell in 1883, and said that now that no novelty existed in regard to the system they had to consider that some experience had been gained between 1883 and 1896, and it did happen that the system was in process of being discarded. In October, 1883, Mr. Lockwood attended the convention at St. Louis when the call or Law system was dealt with. The remarks he then made induced the superintendent to look up the English records, and he found that the Law system stood very well on the list of those towns that had a large number of telephone services. He also found a statement showing the number of subscribers in the four large Scotch towns during the last five years. Dundee and Aberdeen had been using the Law system during that period. Edinburgh had been using the indicator system, and Glasgow had been using both systems. The subscribers in Aberdeen had increased 82 per cent.; in Dundee they had increased 57 per cent.; and in Edinburgh they had increased 140 per cent. That was not enough for them to assume that it was in any way a conclusive comparison, because four towns were hardly a sufficient number to make an average. He only put that forward as a suggestion whether the Law system was or was not a progressive system. With regard to the extent to which subscribers made use of their telephones on the various systems, he found that Glasgow had six and a half calls per day per subscriber, compared with Liverpool; that was just one-half. If the Law system facilitated subscribers, and was of use to them, they must consider how much they used it. All the towns using the Law system were somewhat below the towns of similar size in the United Kingdom. Mr. Sinclair had told them that the subscribers liked the call wire: that 95 per cent. of them in Glasgow preferred the call wire to the indicator system previously in use. The weak point about that statement was that they had not all the material before them on which to form a judgment. What they wanted to know was, what was the indicator system previously in use? He attached very much more importance to Mr. Sinclair's statement that, having studied the matter as an engineer, he was of opinion that the Law system should be introduced. With regard to flat boards they were originally introduced in the Law system before the introduction of the multiple switchboard. Mr. Kingsbury dealt at some length with the advantages of the upright boards as compared with the flat boards, and said the real controlling factor was not electricity at all, it was simple anatomy. A man could describe a complete circle with his arm vertically, but horizontally he could only describe a semicircle and, therefore, a multiple switchboard on the upright had double the capacity of a switchboard on the flat. The comparisons as to cost in the paper were made entirely on what might be called the old times. Each operator in those days had 50 subscribers: now they had boards made for 450 subscribers worked by three operators, and boards of 360 were quite common, giving 120 subscribers to one operator. The whole question between the upright board and the flat was simply a question of saving working cost or saving working expenses.

Mr. Binswanger said he had had his doubts as to how the public would take to the call system; but from experience he could say that he could endorse everything Mr. Sinclair had said upon this subject, and that in spite of the remarks of Mr. Kingsbury. They had occasion in Manchester to use both the call system and the annunciator system side by side, and his own experience was that the call system was preferred. They felt they were in more direct communication with the exchange, and also with the subscribers. They certainly got a much quicker service. It was a question whether they could not put more work on the subscribers and thereby make the exchanges more automatic. He was told an automatic system was in operation in several places in America, having subscribers up to 200. It would be extremely interesting and useful if they could hear from Mr. Sinclair what he thought of automatic systems. If such a system could be devised, which was both simple and reliable, it would be extremely useful in small exchanges.

Mr. Preece complimented Mr. Sinclair on his paper. It was the first time a representative of the National Telephone Company had come forward to read a paper before that Institution and tell them what the company was doing. He (Mr. Preece) had in the past spoken very strongly upon the management of the National Telephone Company. It had been execrable. But a change had now come over the spirit of their dream, and the company was not only repairing the damage of the past, but was showing an amount of enterprise and energy which would put the telephone industry in this country into a position which would enable it to compare favourably with any other country in the world, America not excepted. He had seen much of telephone working in America, Norway, Sweden, Germany, and other countries, and he found that the National Telephone Company was taking the cream of what had been done elsewhere, and we in England were to reap the benefit. Mr. Preece added that he disagreed with Mr. Sinclair on the subject of multiple switchboards, and thought that the day of the multiple board was almost over, since as the exchanges grew the expenses of them became too great. When the number of subscribers reached 5,000 the difficulties were enormous. He could not speak on trunk working at present, as the Post Office had only just taken over the lines, but he hoped that by the commencement of the next session of the Institution they would have in England the finest trunk line system in the world, and he also hoped that the next session would be opened by a paper on the subject by Mr. Gavey, who would describe it. As to the call system, or Law system, Mr. Preece objected to i because it was actually unnecessary. In the Post Office their cal was automatic, and there was only one objection to that—namely, that a continuous current was required to work it, and that was no real objection to those who had tried it. He did not like flat boards for practical reasons—namely, the difficulty of the engineer removing faults while the operators were at work. In the vertical boad that could be done without the operator knowing anything about it. Another point was that, though the operators might be perfect and the apparatus perfect, it was wanted to have subscribers equally clever to get the best results. Without mutual forbearance and assistance from the public they would never get satisfactory telephone working in this country. There was a great deal of difference in this respect between the way the telephone was worked in London and Berlin. In the latter city the subscriber did much of the work. He gave the number, was put through to his friend, and did the calling, and all the rest.

(To be continued.)

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THAT WORKMAN AGAIN.

A "workman," says the highest authority, "is worthy of his hire." Everybody is ready to agree to this, but differences of opinion arise in the definition of "workman." The real article is to be honoured and respected; the makeshift, make-believe merits neither honour nor respect, but rather to be reprobated. It is not with the real workman we have again to deal, but with the makeshift. Carelessness upon a railway is almost certain to lead to an accident; similarly, carelessness in electric light fittings may lead to the destruction of property and danger to life. Even if the end of such carelessness be not disastrous in these ways, the probability is that it must lead to an almost continuous loss of current, and hence of money. Under the best circumstances, bad workmanship means greater than normal leakage, and this leakage has to be paid for by the consumer or the shareholder. A diatribe upon electrical fittings might well be divided into three parts—one directed against the employer who acts as if he believes he can get the best at any low cost; and one against the contractor whose performances do not come up to his promises. The latter winks the other eye; he has to make a profit somehow—for "he must live," you know. We, however, are not concerned with his living in any particular capacity, and if he is not straight as a contractor, the sooner he finds a living in some other capacity the better for all concerned. According to present information, we are inclined to the opinion that the worst features of electrical work are neither due to the parsimony of the employer nor the fraud of the contractor, but to the actions of the third party against whom the diatribe may be directed. This third party is the self-called intelligent workman—in reality, a make-believe, a dishonest, scamping rascal. We must again guard ourselves against the misinterpretation of our language. It is not directed against the real Simon Pure, only against the makeshift. The latter puts us in mind of the critics who play the fool before all the world in their weekly remarks upon contemporary technical literature. The makeshift in all trades arrogates to himself infallibility. He is the Alpha and the Omega, the embodiment of the laws of the Medes and Persians, the one and the only Jones. The real workman may be said to be only individually one of the vertebræ and collectively the backbone of the universe. To guard against the electrical make-believe workman the fire offices have to issue stringent rules, and to employ inspectors who examine the work carried out. What a tale these inspectors could tell, which if told, however, would do more harm than good. In another column we give sketches from actual work condemned and taken out of houses in the West-end of London. Our examination of the actual material brings us to the—we think—only possible conclusion, that neither employer nor contractor can be blamed, but only the makeshift workman. As a matter of fact the contractor must have been a considerable money loser, because the work had

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to be done again to the satisfaction of the inspector. How much of this kind of work is hidden it is difficult to imagine. It is quite certain that the supervision of master, foreman, and inspector cannot be constant, and that at the best the examination by the latter cannot be certain of detecting every fault deliberately made by makeshift workmen. A man either knows or does not know how to make a joint. If he does not know, he should not undertake the work; if he does know, and makes a bad joint, he must do it deliberately, and all the adjectives in the English or any other language are insufficient to justly condemn his work. He knows the danger awaiting property and life, and yet he wilfully puts both into jeopardy. Let the men who seem to support this kind of thing find an excuse if they can; we own to having failed to find any. The case would be different if no harm could come of such work, but we all know that the multiplication of bad work increases many risks which ought to be avoided. Since the samples of English work we have commented on were brought to us we notice an address by Mr. C. C. Haskins to students at Chicago, given in our American contemporary, the *Electrical Journal*. Mr. Haskins directs attention to good and bad wiring, and, summing up his conclusions in favour of an exceedingly high standard of work, among others, gives this reason: "Because in electric work the best is none too good," and states that his motto has always been, "Fix it so it cannot, and it will not." The worst feature in these cases is that, though the work is often done through sheer carelessness or incompetence, the faulty portion happens to come in a position exceptionally dangerous. Hence condemnation should be constant and emphatic.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE INSTITUTION BALANCE-SHEET.

SIR,—I feel sure there are many who thank you for the outspoken comments on this subject, for, whatever Mr. Raworth may say, you have hit the nail on the head. It appears to me that the position of affairs is somewhat as follows:

Cause.—In an interview published by one of your contemporaries* in August last year, Sir David Salomons was straightforward—I use this word because there has been a great deal of molly-coddling of the Brush Company in the matter—enough to make statements about certain apparatus at the Bankside station. This must have wounded Mr. Raworth's feelings greatly, especially the references to the (40 yards sprint race) switch pillars. Those who have spoken to the attendants at the Bankside station will know what I mean.

Effect.—The first effect noticeable was the dead set made against Sir David Salomons being elected president of the Institution, and I am convinced that the nucleus of this action was in the quarter I have indicated. You yourself have pointed out effect number two, and commented upon it.

To conclude, I should like to know if our Institution is going to be ruled (the American word "bossed" more nearly expresses it) by a few Brush Company's officials and their worshipping admirers. If not, then the sooner Mr. Raworth confines his speeches at the Institution to technical matters, the better it will be for everybody.—Yours, etc.,

ANTI-SHOUTER.

* *Lightning*. August 15, 1895.

THE SNOWDON RAILWAY ACCIDENT.

SIR,—Although Mr. Lea in his letter anent the above, published in your last issue, disclaimed any serious attempt to theorise, yet his remarks involve one or two points which need correcting, especially in view of the evidence given at the inquest.

The accident was undoubtedly due to the track having settled, owing to subsidence of the soil, which is notoriously subject at this point to the influence of weather. No blame whatever ought to be attached to the engine or to the rack.

As for the question of electric motorcars being safer than, and generally superior to, steam locomotives, this may or may not be the case according to the respective gross weights in regard to such a circumstance as the runaway on Snowdon.

Undoubtedly electric motorcars would have involved less weight than the use of steam locomotives, but even then the train load might have been enough to depress the rails at this spot and so have caused the whole train to run off instead of the locomotive alone.—Yours, etc.,

A.M.I.C.E.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

April 17, 8 p.m.—At the Institution, Great George-street, Westminster. Students' meeting. "Recent Developments in Lighthouse Engineering," by N. G. Gedye (student).

April 21, 8 p.m.—At the Institution. Ordinary meeting. Papers to be discussed: "The Thirlmere Works for the Water Supply of Manchester," by C. H. Hill (member), and "The Vyrnwy Works for the Water Supply of Liverpool," by G. F. Deacon (member).

April 23, 2.30 p.m. Students' visit to the Linde British Refrigeration Company's works at Lower Shadwell. Train leaves Fenchurch street Station for Shadwell at 2.10 p.m.

Institution of Electrical Engineers.

April 24, 8 p.m.—At the library of the Institution, 28, Victoria-street. Students' meeting. "Underground Conductors," by E. Ray and V. Watlington (students).

Institution of Junior Engineers.

April 17, 8 p.m.—At the Westminster Palace Hotel. Paper on "Dredgers," by W. J. Hunter.

Physical Society.

April 24.—At Burlington House. "Symbolism in Thermodynamics," by R. A. Lehfeldt. "Adjustment of the Kelvin Bridge," by R. Appleyard. "The Effect of Wave Form on the Alternate-Current Arc," by J. Frith.

Royal Institution of Great Britain.

April 17, 9 p.m.—At Albemarle-street, Piccadilly. Lecture by Prof. G. Lippmann on "Colour Photography."

April 23, 3 p.m. Second lecture by Prof. Dewar on "Recent Chemical Progress."

Society of Arts.

April 20, 8 p.m.—At John-street, Adelphi, W.C. Cantor lectures on "Precious Stones," by Prof. Henry A. Miers, M.A.

April 22, 8 p.m.—Ordinary meeting. "The Perfected Photochromoscope and its Colour Photographs," by F. E. Ives.

April 23, 8.30 p.m.—Indian section. "The Deserted City of Vijianagar," by Captain Charles Rolleston.

WIRING WORK.

A good deal has been said and written lately about the wiring question. The unfortunate fire insurance inspector has been hauled over the coals and ridiculed by several would-be witty individuals, and it has been stated that the time will soon come when electric light installations will be treated by the fire offices in the same manner as gasfitters' work. How much of the feeling against the fire office inspectors is due to the fact that the objected work does not fall in with the requirements of the fire offices is hard to ascertain. The inspectors are, with few exceptions, reasonable men, and must not be always blamed because certain bad work has to be condemned. Some samples cut out of some London installations have recently been submitted to us, from which the following illustrations have

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been made; they show to what extent bad work is often hidden away before the inspection takes place. The chief fault is in the joints, which are badly made, badly soldered, and badly insulated. The uncovered joint in Fig. 1 shows the careless way in which the ends of a stranded conductor were left projecting, and hence injuring the insulation. The other conductor leading from the joint broke when handled, as the wire had been nicked by the pliers. No single joint showed any care in laying up the wire, and the majority of the joints had just received a wipe from a soldering iron.

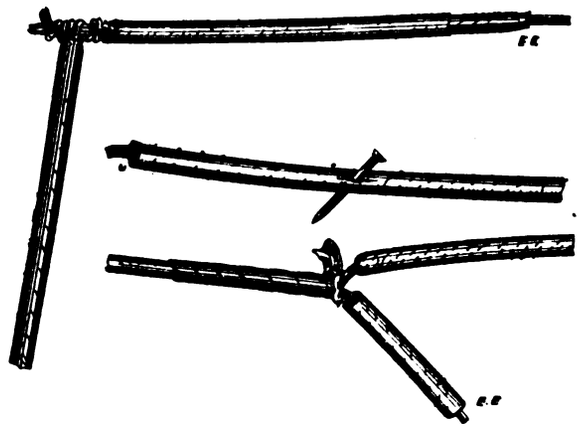

FIG. 1.

The solder under adhered to the outside, and had not sweated through to the centre of the joint. The insulation of these joints was not defective on account of insulating material, but due to bad workmanship. As will be seen from the illustration, the other joints and the body of the joints were well covered, but the ends were left practically open. Nails were largely used in fixing on the covers of the casing, and several wires were found pierced as shown. In this insulation the fuses were often situated under the floors.

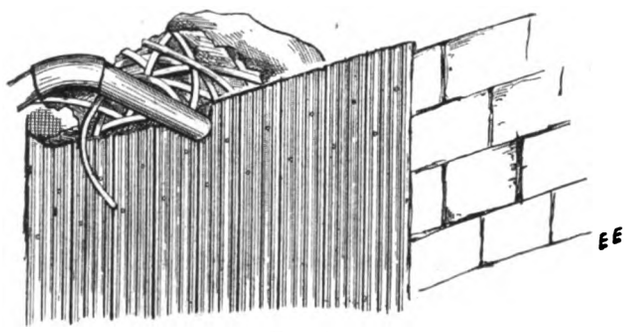

FIG. 2.

Fig. 2 is illustrative of wires bunched under a concrete floor, and in close proximity to iron girders and gas-pipes. As will be seen, the work would look tidy till the upper cover is taken off. Fig. 3 shows the method of tubing a wire through a road without any mechanical protection.

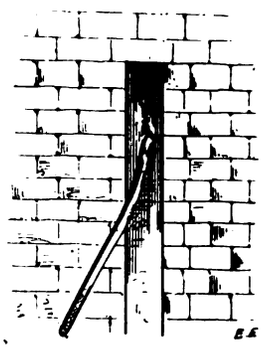

FIG. 3.

When such work as the above is put in with the knowledge that there will in all probability be an inspection, what may be expected when the contractor's word is taken as to the class of work? The adoption of a conduit system would to a great extent extinguish the jerry wireman, for the conductors, if properly installed, could be easily withdrawn for inspection; but with the use of wood casing it is to be feared that there are numbers of joints and faults similar to the above that will never see light, unless it be artificial light, inasmuch as they may sooner or later be the cause of fires.

A CENTRAL-STATION PROBLEM.*

BY C. R. VAN TRUMP.

An axiom that applies particularly to central-station operation is that what is good engineering for one case may be very doubtful in another. Probably we may never be so fortunate as to outlive all the errors of commission or omission which are to be met with each day in central-station practice, and the greatest errors are sometimes justified by the best practice of the day. Indeed, there is no type of apparatus and no method of operation which may be said to fulfil all the requirements. For instance, the central station of which the writer is in charge, and with which this paper deals, stands at or near the centre of distribution of a low-tension, three-wire system which forms three-fourths of the total output, about 600 kilowatts. Being one of the earlier plants, it is supplied with high-speed, non-condensing apparatus, and the haulage of coal amounts to 10 per cent. of the cost of the fuel on tracks; and yet the economy has not been very apparent in favour of moving the generating plant a distance of less than 2,000ft., in order to get water for condensation and fuel on a railway siding alongside fire-room, even with the use of modern steam apparatus. Although this would not seem self-evident, yet, when we consider that though we might hope to save about 40 per cent. in fuel, this item is less than 50 per cent. of the cost of current, and only 30 per cent. in our station, as we consider that our produce is electric service, not electric current. We would only gain 40 per cent. of 30 per cent., or about 12 per cent. saving, while the outlay would be about 5 or 6 per cent. of the cost of the current in additional interest, renewals, etc., and the electrical loss would be nearly as much more, leaving a small margin which would hardly pay. Of course, the case would be altered if an entirely new plant were considered.

But another method of getting far better results has been adopted which may prove of interest or practical value to other stations. It is often the case, especially in manufacturing districts, that large amounts of power are used with very poor economy; in fact, enormous wastes are not uncommon, especially in the case of water powers which are used in the daytime and at night are allowed to waste over the dam breast. The plan adopted by the writer has been to contract for this waste power, put in apparatus in the mills of the concern, and transmit all that could be spared to the centre of distribution, the power being bought on a meter basis and distributing on the present system. The mill-owners receive a revenue from this waste which amply pays them; the central station receives the power at lower cost than the ideal plant would produce it, and at very low outlay.

This central station carries a load on a three-wire direct-current system of about 600 kilowatts, covering a territory three-fourths of a mile radius from the station, and a single-phase alternating 125-cycle system load of 130 kilowatts at 1,200 volts, covering a territory outside of the direct-current system of 3½ miles radius, including suburban districts for incandescent work; and finally a constant-current arc load of 150 lights. In the question of economy, the high-tension plants were of first importance, as greater economy was possible with the direct-current apparatus. A sub-station with better economy was deemed inexpedient for these systems alone, as this would divide up the plant to no advantage in operating expense.

A proposition was made to a large cotton mill and dyeing concern near the town to sell current to the central station. The mechanical head of this concern, who, although not figuring as blasé in the engineering world, is nevertheless one of the best posted and deepest thinkers the profession can boast. He considered our proposition with great care. Their conditions were favourable, for besides a large water

* From the *Electrical World*

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power, much in excess of their demands after the hours of operation during the day, they use a large amount of steam for heating purposes at 30lb. pressure. They had engines and boilers in reserve which they operated at 110lb. pressure, and it is very easy to see under such conditions that a simple engine operated at 110lb could be exhausting into the low-pressure mains at 30lb. back pressure, with the excess cost of steam at 110lb. over 30lb., or at less cost than the ideal station with the latest and largest equipment could possibly produce the power. This is apparent since 1lb. of coal is capable of giving about 11,500 B.T.U. to the water in a good steam-boiler, and at 30lb. pressure 1,165 B.T.U. per pound are in the steam, and only 22 more, or 1,187 B T.U. per pound, are needed to produce 110lb. steam pressure, while 1,146, or 19 less, are still in the steam at atmospheric pressure exhausted from a non-condensing engine Therefore, if in steam at 30lb pressure 22 B.T.U. are added per pound of steam, 1lb. of coal would raise 520lb. of steam from 30lb. to 110lb., or produce from 10 h p. to 15 h.p. on 1lb. of coal.

The plans were to meet the following conditions: Their water power was ample to supply 180 kilowatts, and in the daytime the steam power available under 30lb. pressure (their demand for steam being otherwise supplied by a low-pressure bank of boilers) was equal to this. The alternate-current load at dark became 150 kilowatts and dropped off at midnight to 75 kilowatts, supplying principally an incandescent municipal service. All the alternate-current apparatus was built for 125 cycles; the distance from the station to the mills was 12,600ft.; the attendants could not be relied upon for constant attention, although the speed curve showed close regulation of the power. Electrical power was also a necessary feature, both for the station and the mills. No spare electrical apparatus was to be provided, which necessitated keeping the old plant intact. The day load was exclusively direct low-tension current work.

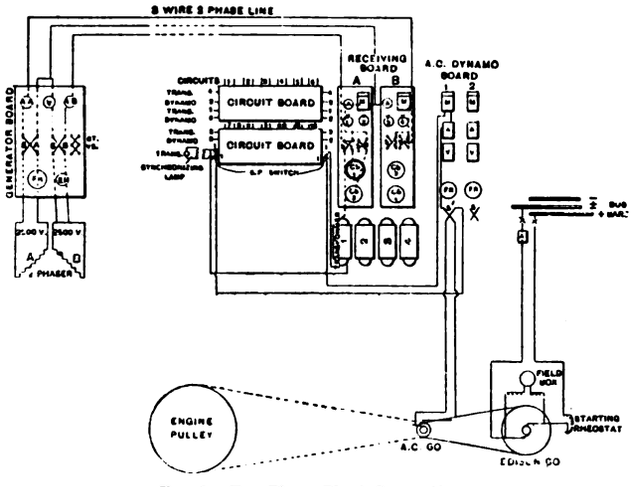

FIG. 1.—Two-Phase Plant Connections.

The plant installed (Fig. 1) to meet these conditions was as follows: A Stanley-Kelly two-phase machine of 180-kilowatt capacity, and 125 cycles, was belted direct to a jack-shaft with clutches so that it could be driven from either water-wheel or one or two engines. The line consisted of 12,600ft. of three No. 00 B. & S. weather-proof conductors (providing for future increase), with square yellow pine poles, 5ft. cross-arms and triple petticoat glass insulators, built to carry the current to the receiving board. Four special step-down transformers, 2,500 to 1,200 volts, were put on each side of the system; one side of the primary of each transformer was connected through the commutating switch, with a kicking coil to prevent short-circuiting, and with 15 terminals on the primary coil of the transformer; thus, with the switch on the first point, with 2,500 volts on the primary, 1,175 volts were available on the secondary of the transformers, while on the last point, with 2,500 volts on the primary, 1,325 volts were available. Ten volts between each point of the commutating switch admitted of varying the pressure on either of the four transformers without a loss or leakage through additional primary coils. The secondaries of the transformers were connected, as indicated, to transformers Nos. 1, 2, 3, and 4, to points Nos. 1, 2, 3, and 4 on each side of the old circuit board, these boards being cross-connected by means of plugs and double throw switches, carrying 12 circuits, so that any circuit could be thrown on either of two of the transformers connected to one of the boards, one on each side of the system, and the load thus perfectly balanced if desired.

Two of the single-phase machines were each placed in line with two 60-kilowatt direct-current Edison generators, driven from a single-expansion engine, so that the belts could be removed from the Edison dynamos and the alternators belted direct to the engine in case they were needed, or the alternate-current 60's could be run as synchronous motors driving the Edison 60's in the following manner: a rheostat was placed in the armature circuit of the direct-current dynamo so that it could be started as a motor; short belts were provided to connect the Edison machines with the alternators, and at the board switches were arranged so that either alternators could be thrown into multiple with one of the transformers on each phase, as shown in Fig. 1, for No. 1 alternator and No. 1 transformer.

The Edison dynamos are started as motors, bringing the

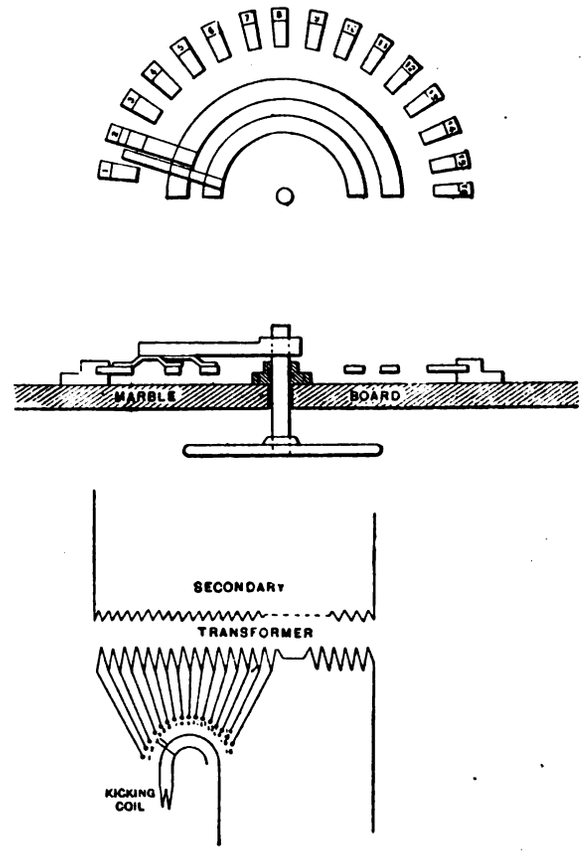

FIG. 2.—Regulator and Connections.

alternate-current 60's up to speed; a small converter and pilot lamp are connected across one of the single-pole switches for synchronising. By this arrangement the alternators are brought up to speed by the Edison machines running as motors; the resistance in the armature circuit is thrown out, and the speed varied by the field box of the Edison machines, the voltage of the alternators being varied by the field rheostat until it is equal to that of the transformers, one side of the alternator being connected to the transformer. The pilot lamp flashes as the machine goes in and out of synchronism, and when the speed is adjusted until synchronism is nearly reached, the pilot lamp goes out; the remaining switch connecting the alternator in multiple with the secondary of the transformer is then thrown, the field box of the direct-current machines is thrown out, and the load is taken by the latter on the three-wire system, the generators driving them as synchronous motors. This operation is performed every day without difficulty, the Edison machines after being thrown taking the load easily and smoothly. No induction losses occur on the lines; in fact, as the field excitation of the alternators is increased the machines kick back on the line

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exactly like a condenser in circuit, counteracting any inductive effect of the line.

By this means, after the alternating-current load drops off at midnight, the synchronous motors driving the 60-kilowatt direct-current machines on the three-wire system are thrown in and carry the load, from 75 kilowatts on circuit board, to which it drops at midnight, up to 175 kilowatts, the steam plant then being shut down.

The plant has been in operation for the past four months with excellent results except a scarcity of water from the excessive drought, the water having until lately run lower than for many years. The only difficulty in operating is during the time the mill machinery and dynamos are both on the waterwheel, which necessitates extreme care in avoiding rapid fluctuations of load. The load is thrown on very slowly and taken off with the same care, as a rapid drop in load on the dynamos tends to make the waterwheel race with its sluggish governor.

THE NATURE OF CHEMICAL CHANGE AND THE CONDITIONS WHICH DETERMINE IT.*

BY DR. ARMSTRONG, F.R.S.

"All the facts show us that that power commonly called chemical affinity can be communicated to a distance through the metals and certain forms of carbon; that the electric current is only another form of the forces of chemical affinity; that its power is in proportion to the chemical affinities producing it; that when it is deficient in force it may be helped by calling in chemical aid, the want in the former being made up by an equivalent of the latter; that, in other words, *the forces termed chemical affinity and electricity are one and the same.*"—Faraday's "Experimental Researches in Electricity," 1834, Series VIII., § 918.

Foremost among the problems to which during recent years attention has been devoted is that of the nature of chemical change. Whilst English workers especially have made most important contributions to our knowledge of the conditions under which change will occur, foreign workers have been most active and successful in developing mathematical methods of treating the subject. Indeed, the statement recently made in a prominent chemical journal that "it has certainly become impossible to read chemical theory without a working knowledge of the calculus" is a striking comment on the alterations in the conditions under which the chemist will work in the future, which must serve to remind us how very different a preparation students must now undergo if they desire to thoroughly master the theories of our science.

The subject first came under consideration in this society just 10 years ago. In the discussion on Mr. Brereton Baker's paper on combustion in dried gases (compare *Proceedings*, 1885, 37), I ventured to insist that the evidence that action did not take place between two substances was so strong that chemists would ere long be forced to form a definite conception of the nature of chemical action and of the conditions under which chemical action could take place; and I then pointed that physicists were in advance of chemists, drawing attention to Ayrton and Perry's paper on the contact theory of voltaic action, in which it is directly stated that Ohm's well-known law is equally applicable to electrical and chemical changes.†

On the occasion in question I defined chemical action as *reversed electrolysis*, and explicitly stated that in any case in which chemical action is to take place it is essential that the system operated on shall contain a material of the nature of an electrolyte. The expression "chemical action" was used as including all cases of exothermic change, cases of endothermic change being obviously comparable with direct electrolyses, as in all such cases energy from without must be impressed on the system.

Later in the year, at the British Association meeting at Aberdeen, in my address to the chemical section, I discussed the matter more fully, and then stated in so many words that the conditions which obtain in any voltaic element are those which must be fulfilled in every case of chemical action. I carefully pointed out, however, that there was nothing new in this, and to justify my assertion drew attention to various passages in Faraday's "Experimental Researches in Electricity" in which such a doctrine is laid down in the clearest possible terms. Let me here again say that nothing is to me more surprising than the continued disregard of Faraday's teaching on this subject. We know that in regard to purely electrical questions, even in this country, it was not until Clerk Maxwell came forward as his interpreter that attention became riveted upon his conceptions; and abroad, even Clerk Maxwell was disregarded until Hertz's experimental demonstration ensured that respect being paid to his pleadings which they were so long denied. Faraday's views regarding chemical action have never yet received proper notice, although the language in which they are expressed is so simple and direct that they cannot be misunderstood, and their completeness is surprising.

But one conception has been added to Faraday's teaching—that of "electrolytic or ionic dissociation or ionisation." Although introduced by Clausius in 1857, it lay dormant until it was reintroduced and applied by Arrhenius in 1884, who gave to the hypothesis a quantitative form; but it did not become popular until 1887, when Van't Hoff introduced the conception of osmotic pressure. The successful application of the hypothesis in explanation of the abnormally high results obtained in the case of conducting solutions at once secured for it a very large measure of support. Whatever view may ultimately be taken of the hypothesis—whether it be retained as a permanent addition to our theories or not—its introduction has been eminently fruitful of results, and an already too voluminous literature of the subject has grown up with surprising rapidity. Yet it appears to me that it has been accepted by a particular school—at the head of which stands Ostwald, and who regard and treat all unbelievers as heretics worthy of the stake—not as a mere working hypothesis, but as an absolute creed, without any sufficient attempt having been made to discuss its *general* probability. And the application of Avogadro's axiom to solutions, however successful as affording a mathematical method of discussing results, in principle involves the complete disregard of the essential difference between the liquid and gaseous states, and of the fact that in liquids the molecules are subject to a control which they mutually exercise and which distinguishes the liquid from the gaseous state. Also, it must not be forgotten that the arguments made use of apply almost entirely only to weak solutions—to solutions to which a law of simple proportionality may be expected to apply: that, in fact, the region explored is one in which the rate of change is represented practically by a straight line. Lastly, it is applicable only to electrolytes. Personally, I am still entirely unconvinced of the validity of the hypothesis, although no one can be more willing to admit that in so far as *weak* solutions are concerned, a "law" has been discovered which is broadly true *in mathematical form*, however open to question the fundamental premises may be on which it is based. I am satisfied, also, that the phenomena of chemical charge are as a rule far more complex in character than is assumed by the advocates of the hypothesis.

If electrolysis, and, therefore, electrolytic conduction, be—as I contend, and have long contended—conditioned *by a conjoint influence* exercised by the solvent, A, and the dissolved substance, B, there is, I imagine, no reason why other phenomena in which the conjoint influence of A and B comes into account should not be expressible in mathematically similar ways. In extenuation of such heresy I can only quote Clerk Maxwell's argument that if in a battery a septum be used which diminishes the diffusion, it is probable it will increase in exactly the same ratio the resistance of the element, because electrolytic conduction is a process the mathematical laws of which have the same form as those of diffusion, and whatever interferes with one must interfere equally with the other, the only difference being that diffusion is always going on whilst the current flows only when the battery is in action.

It has always appeared to me that the chief objection to be urged against the ionic dissociation hypothesis is the fact that, of the very large number of compounds known to us, extraordinarily few are electrolytes—not even metallic chlorides generally are conductors, but only a very limited number, and it is particularly remarkable that whilst such inactive substances as lead and silver chlorides, when fused, are among the best conductors known, aluminium chloride—one of the most active compounds with which we are acquainted—is apparently not an electrolyte. Electrolytes are clearly a very limited class, and if we consider the general properties of compounds which conduct more or less readily, whether alone or in solution, and contrast them with compounds which are practically dielectrics, it is impossible to discover any good reason why "ionic disruption" should take place in the case of the one set and not in that of the other. And if, confining our attention to acids, we contrast those which in solution are apparently good conductors with those that are bad conductors, there is again no satisfactory "motive" for so considerable a difference discoverable; for example, taking sulphuric and acetic acids, why should the former suffer ionic dissociation so readily and to so considerable an extent and the latter to so slight an extent. I imagine that it is fair for this purpose to regard the acids as modified water, and to assume that the slight tendency of water to undergo ionic dissociation—of which more later

* Presidential address delivered before the Chemical Society.

† "Hitherto chemists have only employed the two ideas of chemical affinity and the amount of chemical action, but we have shown that these ideas are simplified when regarded as E.M.F. of contact and currents of electricity. To connect the two ideas we have a third—viz., *resistance*, and the electrical law of Ohm becomes the chemical law—*the quantity of chemical action in unit time equals the sum of a great number of terms, each of which is an E.M.F. divided by a resistance.*"—Ayrton and Perry, *Proceedings*, Royal Society, 1887, 27, 227.

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on—is enhanced by the association of the water with the oxygenated group, and that whereas sulphuric anhydride has a marked effect, acetic anhydride has a very slight one. Yet this is hardly satisfactory, and would probably involve the conclusion that sulphuric acid should diminish in conductivity as the temperature is raised, as it then dissociates into anhydride and water. The very different behaviour of sulphuric and acetic acids when vaporised, the former, but not the latter, undergoing dissociation, may be regarded as an indication that a similar change does not take place in the case of acetic acid, and, therefore, it might be supposed that acetic acid would undergo ionic dissociation to a far greater extent than is assumed to be the case as a consequence of the anhydride retaining its influence.

It may possibly be contended, as it has been in the case of water, that compounds generally are conductors to a very slight extent, but as all bad conductors seem to become worse conductors as they are more carefully purified, the burden of proof rests upon those who make such an assertion ; and it is not in accord with the fact that very many such compounds are as active as compounds which conduct well, and which are therefore, by hypothesis, more or less fully dissociated. For example, acid chlorides generally act on alcohols generally with very considerable readiness under conditions under which the halhydrides produce but a slight effect.

With regard to water itself, to argue, as Arrhenius, Ostwald, and others have done, from the hydrolytic action of water on the salts of weak acids and bases, that water to a certain but very small extent contains ions—that is, H and OH—is but to beg the question entirely, and a clear case of reasoning in a circle.

The recent redetermination of the electrical conductivity of water by F. Kohlrausch and Heidweiller gives the value $0{\cdot}04 \cdot 10^{-10}$ at 18deg., instead of $0{\cdot}25 \cdot 10^{-10}$ previously arrived at by F. Kohlrausch. These authors have deduced from their results a value for the conductivity of *pure* water — viz., $10^{10} \cdot \kappa = -0{\cdot}0361$. They calculate that if this conductivity be due to the presence of water ions, a cubic metre of water at 18deg. would contain 0·08 milligramme of dissociated hydrogen ions ; and point out that if present only in this excessively minute proportion, there would still be milliards of atoms of hydrogen per cubic millimetre, and neighbouring atoms would be separated by distances of the order of light waves in dimension. These conclusions, however, are based on the acceptance of the view put forward by Arrhenius, that the dissociated ions alone conduct the current—from my point of view, therefore, it is a case of deducing one unknown with the aid of another unknown—of proving one assumption by another assumption, which is admittedly an unsatisfactory proceeding. I venture to think that it is still open to question whether pure water—indeed, whether any *pure* substances outside a very limited number perhaps, such as the silver haloïds, etc.—be an electrolyte. Minute in the highest degree as the amount of impurity in the water examined by Kohlrausch and Heidweiller must have been, yet even this may have exercised a very considerable effect, and, in fact, there is clear evidence in the paper that an extremely minute amount of impurity does so act. Moreover, the difference between the lowest observed value and the corrected value appears disproportionately small when the reduction of the value previously obtained by Kohlrausch, effected by the removal of what, after all, must have been a very minute amount of impurity, is considered. The point is one of the utmost importance, and cannot be lightly brushed aside.

The methods made use of in calculating the amount of ionic dissociation of water are apparently all open to the criticism that they are based on eminently hypothetical premises, and it is particularly open to question whether the phenomena from which fundamental values have been deduced have received the proper interpretation. For example, the origin of the E.M.F. developed in liquid couples such as have been studied by Worm Müller, and much later by Nernst, and of the concentration currents of von Helmholtz, is by no means clear. Nernst assumes that in such cases forces acting at the electrode surfaces are entirely eliminated, but, if so, it is not clear why any more than when an acid neutralises an alkali an E.M.F. should be developed, for I imagine that in all such cases the changes take place within closed circuits. In fine, I am inclined to doubt whether polarisation effects can be regarded as eliminated ; the enquiry must be included with that into the existence of a true contact difference of potential independent of chemical change. The values deduced by Ostwald are based on the study of couples of the form : platinum-hydrogen | acid | alkali | hydrogen-platinum, and it is assumed that the E.M.F. developed is due to the formation at the one electrode of water from the hydrogen and the OH ions in the liquid, and at the other of hydrogen from hydrogen ions in the liquid and the hydrogen of the electrode. Unfortunately the description promised of the experiments has not yet been given, and it is therefore difficult to criticise them ; it is not impossible, however, that the real cause of the E.M.F. was dissolved oxygen.

Pure liquids do not conduct, according to Kohlrausch, because (as Ostwald has put it, "Brit. Assoc. Report," 1890, 335) their molecules have no space within which to resolve themselves into ions, and it is therefore not improbable that water would conduct electrolytically—and I presume that Ostwald meant even to imply that it would be a good conductor, as he immediately afterwards spoke of water, too, containing ions to a certain but very small extent, if we could find a suitable solvent for it. But we never have found a suitable solvent, unless it be hydrogen chloride. The fact that single substances such as the silver haloïds, when liquefied, readily conduct would appear in itself to be a sufficient argument in controversion of Kohlrausch's explanation of the influence of the solvent. Moreover, it is to be supposed that any liquid capable of acting as a solvent should condition electrolysis if the function of the solvent be but to act as a screen.

As a matter of fact, there is good reason to think that among liquids *water is the only effective solvent that we can use* !

Alcoholic and some other solutions, it is true, conduct more or less well, but it is by no means improbable that when every precaution is taken to deal with highly-purified materials, and especially to dehydrate the alcohol as fully as possible, such solutions will be found to be practically destitute of conducting power. This is the more likely now that Perkins has established the incorrectness of the supposition that until recently has always been made that hydrogen chloride, when dissolved in alcohol, acts fairly readily on it (*Trans.*, 1894, 23). The observations made by Coldridge showing that solutions of hydrogen chloride in stannic chloride are but slightly conductive, are also significant (*Phil. Mag.*, 1890, 29, 383).

If it be assumed that even pure water is to some slight extent dissociated, it is, at least, probable that liquid hydrogen chloride would contain some small proportion of ions prior to admixture with water, and, in point of fact, it is impossible to urge any reason why the one compound should be regarded as more dissociated than the other in the pure state. Yet the "ionists" not only assert that when hydrogen chloride dissolves in water it becomes almost completely separated into its ions, but make the arbitrary assumption that practically it alone is dissociated, the extent to which the water is dissociated being, indeed, diminished by its admixture with hydrogen chloride, according to their view. This question is of fundamental importance as bearing on the validity of the argument on which Ostwald and others have sought to base a method of determining the heat of formation of water from its ions and on the interpretation they have given of the changes attending the neutralisation of acids by alkalies.

I long ago insisted that we have no right to draw any marked distinction between hydrogen chloride on the one hand and water on the other, inasmuch as, in so far as the chemist can test them, they do not differ markedly in stability. I venture to think that no sufficient answer has been made to my objection. To say that analogous compounds such as NCl_3 and PCl_3, or N_2O_5 and P_2O_5, exhibit differences equal to those manifested between HCl and H_2O is incorrect and beside the point—they are vastly different in stability ; water and hydrogen chloride are not (compare Ostwald, *Ze t physikal. Chem.*, 7, 418). So long as it was asserted that water, *per se*, underwent no change, the position was, perhaps, in a measure defensible ; but when it is argued that pure water does dissociate into its ions, this advantage is sacrificed ; the possibility of a change taking place in pure water being granted, it is no longer justifiable to draw a hard and fast distinction between water and hydrogen chloride. This argument is most materially strengthened by the fact that the majority of compounds are not electrolytes.

Although those who uphold the ionic hypothesis regard the solvent as mainly inactive, yet they do not deny that it may exert some influence comparable with that exercised by raising the temperature (compare Ostwald, *Zeit. physikal. Chem.*, 1891, 7, 421 ; *Lehrbuch*, second edition, 1, 776). But it is impossible to gainsay that it has an altogether extraordinary effect in many cases. For example, in the case of hydrogen chloride, it is only necessary to mix this with nine molecular proportions of water to obtain a solution of maximum conductivity, in which, if we are to believe the ionists, nearly the whole of the dissolved hydrogen chloride is resolved into its ions. It is scarcely conceivable, however, that so small a proportion of water molecules should suffice to practically entirely prevent the reunion of ions which cannot by hypothesis be kept apart in the absence of the solvent ; and the conclusion is the more striking if it be remembered that, according to Ostwald, hydrogen silicon fluoride only begins to undergo hydrolysis when present in a solution to the extent of less than 1 per cent., a very large proportion of water being required to prevent the reversal of the interchange $H_2SiF_6 + 2H_2O = SiO_2 + 6HF$; in other words, a compound which is almost generally regarded as a molecular compound is far less readily broken up* than one of the most stable of "atomic compounds."

* Incidentally it may be asked, how is the formation of hydrogen silicon fluoride from solid silica and hydrogen fluoride to be explained, and how are we to reconcile the fact that action takes place with such extreme readiness when hydrogen fluoride is by hypothesis so slightly dissociated ?

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Or, taking the case of sulphuric acid, how are we to satisfactorily explain by the ionic dissociation hypothesis the fact established by F. Kohlrausch that the amount of acid required to form a solution of maximum conductivity increases as the temperature rises from 30·2 at 0deg. to 35·4 per cent. at 70deg. ? If, however, electrolysis occur within a system of acid and water molecules, as a rise of temperature would promote the occurrence of dissociation in such a system, a larger proportion of acid would be required at higher temperatures to maintain the system of the same average composition.

In fact, I believe it is impossible to deny that the solvent is intensely active, and that it is no mere screen preventing re-combination of the ions—it is rather to be supposed that the occurrence of electrolysis in a solution of hydrogen chloride, for example, is in some way directly conditioned by the conjoint influence of the solvent and the dissolved substance ; that electrolysis is not merely an affair of atoms, of ions, but of complex molecular systems ; and, most important of all, *that water, perhaps, is altogether peculiar among solvents as furnishing solutions which can be electrolysed.*

Having thus considered some of the apparent anomalies of the ionic dissociation hypothesis, I may now briefly refer to evidence of its insufficiency in the case of interactions in which substances are concerned which are not electrolytes—a condition which is not fulfilled in the case of a very large number—indeed, an overwhelming majority—of carbon compounds. No doubt it may be asserted that, at all events, the agent used is dissociated, and that, consequently, the compound which is attacked is subject to the action of the ions just as the zinc is in a voltaic cell.

But is this a sufficient explanation ? Consider the case of the hydrolysis of sugar—admitting, for the sake of argument, that when this is effected by dilute acid, the ions of the acid and of water either simultaneously or successively attack the sugar molecule—how are we to explain the action of the enzyme invertase ? This cannot well be regarded as an electrolyte ; and it is not sufficient even to assert that it does, to some slight extent, undergo dissociation into ions—it acts so readily, more readily even than an acid which, by hypothesis, is to a very great extent dissociated, that if at all dissociated it is presumably highly dissociated. The selected action of enzymes on glucosides, etc., is also very remarkable, as acids do not act selectively.

Difficulties such as appear to beset the ionic dissociation hypothesis are not met with in considering the alternative *association* hypothesis, and if this can be shown to be compatible with electrical requirements, it should command more general consideration—in fact, there have been many indications of late that this view is once more coming into prominence. Briefly stated, the hypothesis involves the assumption that complication, not simplification, precedes most, if not all, chemical changes ; that complex molecular systems are first formed from the interacting substances, and that these on breaking down suffer rearrangement of the parts, such rearrangement taking place in consequence of elements which were previously separate being brought into one common "sphere of activity" within which it is possible for them to interact. The function of condensing and other agents—of catalysts generally—on this hypothesis is that of collecting into one system the various elements necessary for the occurrence of a particular change. Such systems may be regarded as, and, in fact, would be, closed voltaic circuits or potential circuits requiring only the removal of a resistance to convert them into closed circuits. The action of aluminium chloride, for example, in conditioning the formation of homologues of benzene from the two substances benzene and methyl chloride—both undoubtedly dielectrics, I imagine, which when together alone are entirely without action on each other—may be ascribed to the formation of an unstable compound of both with the metallic chloride. In like manner it may be supposed that ferric chloride conditions the interaction of bromine and benzene by combining with both, and so bringing them both within each others range in an unstable system. The function of enzymes in promoting hydrolysis, referred to above, on this hypothesis, consists in bringing water into conjunction with the carbohydrate by combining with both. Lastly, if it be assumed that a solution consists of dissociable molecular compounds of solvent and dissolved substance, the occurrence of change on dissolving two substances in a common solvent, as in the case of methyl iodide and silver nitrate in alcohol, may often be conditioned by the solvent acting as "condensing agent" or catalyst.

Prof. Fitzgerald, who has carefully considered this hypothesis, if I rightly understand his argument, seems to see no difficulty in applying it to the explanation of electrical phenomena. The modification of Grotthus's hypothesis which he has suggested is certainly one which appears to be in entire harmony with chemical experience, and it is so important that the question should be fully discussed, that I venture to quote his statements almost in their entirety from the "British Association Report, 1890," 142, where they are too likely to escape general attention :

"Electrolysis has been explained on two different theories by Grotthus and Clausius. As generally received they differ. Grotthus's theory, as generally given, assumes that the molecules in an electrolyte are both polarised and moved by the electric forces within the liquid. This seems so far untenable that it would appear that double the electric force would double both the polarisation and the motion of the molecules, and so should produce four times the electrolysis. The objection, however, assumes that we know the causes resisting the motion, and with proper and not very improbable assumptions as to the resistance to motion depending on it and on the polarisation, a linear relation between current and E.M.F.—*i.e.*, obedience to Ohm's law seems possible. A modification of Grotthus's hypothesis in the direction of Clausius's is, however, possible. Suppose that when polarised, the molecules *drew one another apart* at a rate proportional to the polarisation. This at once makes the relation between electric force and the decomposition a linear one, and so satisfies Ohm's law in the case of small currents. It also, so far, agrees with Clausius's hypothesis that it explains electrolysis and double decomposition as properties of the same kind. The molecules in a liquid will occasionally be arranged by accident in a proper polarised condition in a closed circuit for drawing one another apart ; and if the circuit includes molecules of different kinds, there will result double decomposition. There seem to be very serious difficulties in supposing that uncombined atoms are for any finite time free in the liquid ; and the supposition that it is a particular arrangement that is required before exchanges take place, and that with this arrangement exchanges take place of their own accord, seems to explain electrolysis and double decomposition without supposing free atoms to exist within the liquid. . . . . There are some other phenomena that have been explained upon the supposition that free atoms are gadding about in a liquid. Such are the lowering of the boiling and freezing points by solutions of salts and their effect on osmotic pressure. If dissociated atoms are going about in a liquid as in a gas, it seems impossible but that they must diffuse at different rates ; and that this is not observed seems conclusive against the hypothesis, no matter what else the hypothesis may explain. Consider solution simply. Why does chloride of sodium dissolve in water ? There must be some strong affinity between the two of a chemical or semi-chemical nature to break up the cohesion of the crystal ; and it seems reasonable to assume that this same affinity keeps the molecules of NaCl moving about among the water molecules so that they diffuse about. Now if the forces drawing them about be independent of the nature of the molecule, most of the phenomena explained by gaseous laws are explained. Pressure of a gas depends, at any temperature, on the number of molecules and not on their kind. This is Avogadro's law, by which molecular weights are calculated ; and if the forces drawing a molecule about in a liquid are independent of the kind of molecule, the very same law of pressure would hold, the pressure forwards of molecules of different kinds would depend on their number only, and in the same way as Avogadro's law would enable molecular weights to be calculated. In this connection it is well to state that some bodies may be much better able to produce pressure than others, because of their being more easily polarised—*i.e.*, turned into an effective direction. A molecule which could be easily turned into an effective direction would be about twice as effective as a molecule which went about in a higgledy-piggledy way ; and one would consequently expect electrolytes to produce more, nearly double, the osmotic pressure that others did. As to the changes of boiling and freezing points, they seem explicable by exactly the same hypothesis. The reduction of vapour pressure by molecular affinity of dissolved salt would depend only on the number of molecules of salt if all salts have the same molecular affinity for water ; and the same would apply to the change in freezing point. Hence all these phenomena are explained without assuming free atoms, and they are all explained by what can hardly avoid being a *vera causa*—namely, whatever affinities they are that cause solution, which latter is an unexplained phenomenon on the dissociation hypothesis. That it is reasonable to think that the forces keeping the molecules of salt moving about in the water are independent of the nature of the salt, appears from various considerations. In the first place, these forces are in all probability due to the residual affinities of the non-metallic elements. These same forces are probably the cause of crystallisation. These are old suggestions. That these residual affinities should be nearly the same for different combinations does not seem at all unlikely. . . ."

I have said above that the complex systems within which chemical change is assumed to take place would be closed voltaic circuits. It is to be expected that evidence of the occurrence of electrolysis and chemical change as interdependent phenomena within such systems will frequently evade detection, as more often than not we have to do with circuits which cannot be explored ; and on this account also our power of availing ourselves of the energy of chemical change is strictly limited.

(*To be continued.*)

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A SUGGESTION FOR TESTING STREET RAILWAY MOTORS.*

BY GEORGE T. HANCHETT.

The daily inspection to which every capable railway superintendent subjects his motors often fails to detect serious electrical defects which will ultimately prove destructive. The necessity for this inspection is just as great as that for a mechanical inspection, but the time that it has required hitherto has practically barred its general practice. The object of this article is to describe an apparatus which is designed to effectively accomplish a thorough electrical testing of the car in a systematic manner, the amount of time consumed being negligible. Fig. 1 shows an elementary diagram of the circuits. A small room or shed about the size of a switch-tender's house is located near the entrance of the car-barn, and in it is stationed the inspector. By means of a single-pole double-throw switch he connects a section of trolley wire near the entrance to the terminal at his operating table One terminal is connected directly with the ground. Thus it is practicable to run a car on the siding, cut that section of trolley wire off from the balance of the system and put the car through a cycle of tests. Then by throwing back the single-pole switch, live current is once more supplied to the car, and it is allowed to pass on, either in or out, as the case may be. By a judicious choice of instruments the testing may be conducted with great facility. The requirements are a low-reading voltmeter, an ordinary 500-volt

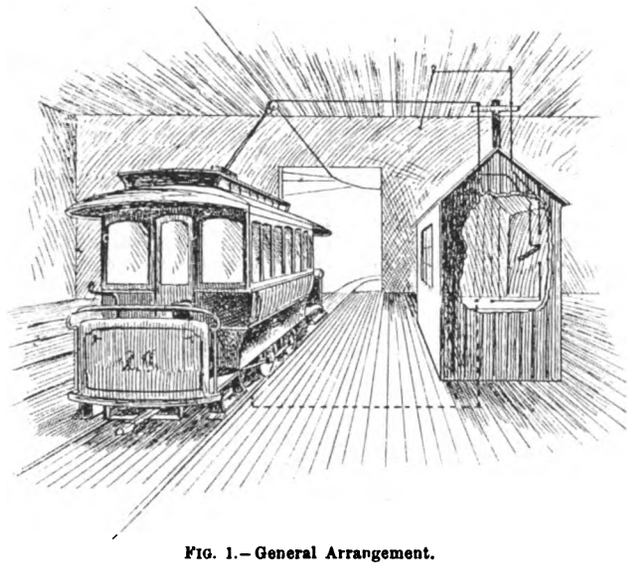

FIG. 1.—General Arrangement.

instrument, a few storage cells and a special connection with the railway circuit The apparatus may be conveniently arranged as in Fig. 2. B represents a storage battery, and it is important that when the switch, *b*, is closed the deflection of V should always be the same and practically equal to the maximum deflection of which it is capable. Thus care must be taken so that the cell is at all times normally charged, but as the amount of current taken from it is very small indeed, one charging should last several weeks Whenever a car equipment is interposed between the trolley and the ground with the voltmeter and storage cell in series, as shown in the sketch, a certain deflection will result, and as the resistance of the equipment is varied by throwing the controller from notch to notch, other deflections will follow which should always be very nearly the same if the car is in good order. If the resistance of the voltmeter is properly proportioned, very slight variations in the resistance of a car on its various controller notches can at once be detected. If a car be run on this section of wire at night and tests out with approximately the same voltmeter deflections that were obtained in the morning upon the various notches, it is pretty safe to assume that the motors are electrically intact. It is particularly to be remembered that relative deflections of the voltmeter are all that are necessary for a complete record. Actual values of resistances need not be sought, as the test is to detect any variation of these from the original condition.

*From the *Electric Railway Gazette*.

In the test for insulation resistance on the ordinary trolley system, the fact that one terminal of the car circuit is grounded necessitates a special switch on the car which shall break the ground connection. Fig. 2 includes an arrangement of apparatus suitable for this measurement. The 500-volt system is grounded through a series of lamps and a water rheostat. A wire from *c* is connected between two lamps near the positive side, and the water resistance, *r*, is manipulated until a certain predetermined potential is indicated upon E, say an even 500 volts. The controller being full on and the ground circuit on the car being broken, throw the switch, C, to its other contact; the low reading voltmeter will at once indicate. Suppose that the minimum insulation resistance allowed be 500,000 ohms, and that the voltmeter has a resistance of 500 ohms and a range of two volts. The other resistances of the circuit are negligible by comparison. Then if 500 volts be applied to 500,500 ohms a current of ·000999 ampere will flow This will deflect the voltmeter 0·4995 volt.

Thus it will be seen that a deflection of ·499 indicates 500,000 ohms. Anything less is of course to the gain of the equipment, and a greater deflection shows that the car does

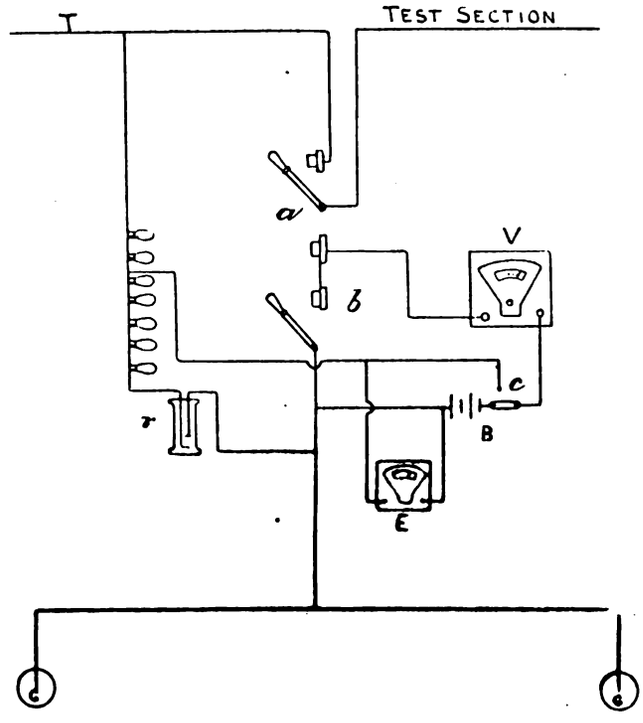

FIG. 2.—Diagram of Circuits.

not come up to the standard. By means of a little calculation and experiment with a car whose equipment is known to be intact, the standard deflection for every notch of the controller should also be obtained and proper limits of variation should be set. With a skilled manipulator the tests should not detain a car more than a minute, and this being the case it is perfectly feasible to test the car in the morning when it goes out and in the evening on its return. By this simple means, short-circuited coils, weak fields, poor contacts at controller fingers or motor brushes, open circuits, weak spots in the insulation can not only be detected, but the day on which the trouble occurred will also be recorded and the reponsibility will be more easily placed The whole outfit of testing instruments may be installed at a very low figure, and the saving in motors and repairs should amply justify the expenditure.

COMPANIES' MEETINGS AND REPORTS.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

The second ordinary general meeting of this Company was held on Monday at Winchester House, E.C., the Right Hon. Lord Rathmore presiding.

The **Chairman**, in moving the adoption of the report and accounts, a copy of which appeared in our issue of March 27, said that he

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thought the shareholders might feel reasonable satisfaction as to the past and increased confidence as to the future. During the period with which the report had to do they had had to deal with some difficulties and to submit to some disappointments and delays such as were almost inevitable in the earlier stages of an undertaking, but they might congratulate themselves that though the Company had been less than two years in existence it already stood upon solid ground. It had already established and possessed a large and important business, and they had good grounds to anticipate that ere long the Company would prove to be a prosperous and very lucrative undertaking. The net revenue for the year 1895 had proved to be sufficient to pay in full the dividends upon the preference capital and to carry forward a substantial balance to the accounts of the present year. That revenue had been earned under circumstances of some difficulty, which, though of a temporary and accidental kind, were still such as to give a good deal of trouble. In reference to certain items in the accounts, under the head of liabilities, an item, "loans against security," referred to amounts received from their bankers in anticipation of the calls upon their preference share issue, and also as against the security of certain investments which the Company had made in quoted stocks. Those investments were steadily rising in value, and it was thought better to postpone selling them until the dividends which were accruing upon them had been received. They had since been sold at a considerable profit, which would go into the accounts of the present year, and, in order to give honour where honour was due, it was right to say that for the success of that operation they were indebted to the deputy chairman (Mr. Braithwaite). The next item was sundry creditors, amounting to £12,260. That sum had already been almost paid off. Turning to the assets side, the expenditures were appropriated, £75,911 to St. Luke's and Clerkenwell and £40,358 to Wandsworth. The item "sundry debtors" represented mainly debts which were due from sub-companies and for interest on advances. Practically, all those had been received since the beginning of the year. The Chairman then referred to the work of the Company as dealt with in the report. At St. Luke's and Clerkenwell, he added, the whole of the street work had been completed. By a temporary arrangement for supply of current they had been able to earn a small profit on the year. All cables had been drawn in, and the remainder of the connections with their consumers were being pressed forward as fast as possible. When their stations at St. Luke's and at Wandsworth were completed—and he expected that would be by the time the winter lighting began—they would have in the Metropolis two large generating stations, one on the north side and one on the south, built and equipped with every modern improvement, having a combined power of supplying some 90,000 lamps, and the power of each of them capable of being easily doubled simply by laying down additional plant. Under those circumstances they might fairly congratulate themselves on the satisfactory condition in which their efforts for the lighting of St. Luke's, on the one side, and Wandsworth, on the other, at present stood. Since the report had been published the provisional order for St. Olave's had been confirmed by Parliament, and had received the Royal assent. The consent of the Camberwell Vestry had been obtained, and they were in a position to secure some neighbouring districts which could all be easily and economically lighted from one generating station. In the provinces the working of their business at Bournemouth had been to some extent interfered with by the change of machinery and the rebuilding of the generating station. This entailed rather heavier expenses than had been anticipated, but, nevertheless, the gross revenue from Bournemouth did to some extent increase during the year, and the working expenses were a trifle less. With the rearrangement of the plant, and some improvements which had been introduced into the management there, the cost of production would be considerably reduced in the present year, and the net revenue increased. During the year 1895 the cost of production was ¾d. per unit less than it was during 1894, and the amount of current supplied during the first quarter of the present year exceeded that of the corresponding period by about 16 per cent. For some time the large and commodious generating station at Dover had been completed, and they had been able since that time last year to supply an uninterrupted current to consumers. Up to the present time the number of connections there was about 4 800 8-c p. lamps, and the manager thought that amount would probably be doubled by the end of the year. At Windermere seven out of the nine local authorities had given their consent to the provisional order, but two still withheld their consent, so that not much progress had been made. At Richmond, in Surrey, their investment had turned out better than was expected; for, instead of a loss of nearly £1,000, as sustained in 1894, there had been a profit of over £200 on running the station. The units sold in the quarter just ended exceeded those sold in the corresponding quarter of 1895 by about 19 per cent., while the expenses were lower, so that before long they might expect that the Richmond station would provide a satisfactory profit. In October last, their manager (Mr. Lawson) was struck down by fever, and they would have been very seriously embarrassed had not Mr. Garcke consented to give them the valuable aid of his experience. They were glad to see Mr. Lawson again with them, but they would continue to enjoy the advantage of Mr. Garcke's advice and assistance, as he had accepted the place on the Board which was made vacant by the resignation of Mr. Denny. It was in the nature of such a company as the present one that in its earlier stages the expenditure should be very heavy and the revenue comparatively small; but the Chairman believed they had already reached firm ground, and that as time went on would find the capital expenditure diminish and the revenue return increase. They had no doubt whatever that they would be able promptly and fully to meet the payments of the dividends upon the preference capital, and that before long the ordinary shareholders would also reap their reward.

Mr. J. B. Braithwaite, in seconding the resolution, said he would like to emphasise what had been said as to the expenditure in the early stages of the Company's existence A certain amount of time must necessarily elapse before the money they spent began to produce revenue. In the case of the City of London Company the supply of current was commenced in 1891, but a dividend on the ordinary shares was not paid till 1894, and then only 2½ per cent. It took another year before the shareholders received their 5 per cent., yet the City of London was considered a very successful company. It was evident that before customers could be got it was necessary to bury money in the streets in the form of conduits and mains, and to erect generating stations. Like a railway company, they must expend nearly the whole of their capital before they could earn any revenue. He would remind them that their district was many times greater than that of the City of London.

The only questions asked were by **Mr. E. R. Smart** on the subject of the item of "preliminary expenses," and by **Mr. Cash** as to the meaning of the "proportion" of directors' remuneration, etc.

The **Chairman**, in reply to Mr. Smart, said that the item referred to related to the expenses connected with the new issue of shares. That issue had been a great success, the shares standing now at a premium. In reference to Mr. Cash's question, the "proportion" was due to an apportionment of the charges between capital and revenue account.

The resolution was then carried unanimously, and the retiring directors and auditors were re-elected.

On the motion of the **Chairman**, seconded by **Mr. Reynolds**, a dividend at the rate of 6 per cent. per annum on the preference shares was declared for the six months ended December 31 last, and the proceedings terminated with a vote of thanks to the chairman and directors.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

An extraordinary general meeting was held on Wednesday afternoon at the offices of the Company, 19, Cadogan-gardens, S.W. The chair was taken by Mr. J. Irving Courtenay, and there was a small attendance.

The **Chairman** said the object of the meeting was to obtain the necessary powers for the increase of the nominal capital of the Company, as all the share capital originally authorised had been issued and fully subscribed. At the general meeting on March 4 last he laid before them fully the position of the Company, but he again called attention to some of the salient points. It was evident that with the growing demand for current in excess of the present capacity of the plant the capital outlay must increase, but the experience gained enabled the outlay to be made to the best advantage and in the most economical manner. The total number of lamps added this year up to the end of March was 4,573, as against 1,098 in the corresponding period of last year, or more than four times as many in the first three months. Formal application had been made to the Board of Trade, under the provisional order, for the whole of the remaining portion of the parish of Chelsea, and as it was unopposed they expected that the application would go through in due course. This comprised the extensive district running from Battersea Bridge along Beaufort-street and by the Fulham-road to the western boundary of the parish. The rapid increase in the demand for current in the present area and this large addition to the district supplied by the Company necessitated the immediate building of a new generating station, which would be erected on their own freehold property, and adjacent to the existing station in Manor-street, and also sub-stations for the distribution of the current. The site selected for the new generating station had space for plant having capacity for running some 50,000 8 c.p. lamps at one time, but it was only intended to erect and equip works in accordance with the demand as it arose, though the complete arrangement had been designed. The works and plant which it was proposed to erect and equip at once would furnish current to about 25,000 8-c.p. lamps fixed, and then there would be the mains and street work, which latter would be laid down with a view to carrying a larger demand as it arose. He desired to call their attention to the fact that the works costs had considerably decreased as the number of units sold had increased. During the last two years there had been a reduction in works costs of 26 per cent., and an increase in the demand for current during the same period of 43 per cent., which agreed with the experience of other metropolitan companies. Upon the general situation he pointed out that they had during the last few years been adding to their renewals fund. They had cleared their accounts of some heavy items which might legitimately have been spread over several years in a suspense account, and they had that year created the nucleus of a reserve fund to which they intended from time to time to make substantial additions. Those remarks were confirmed by the fact that since 1890 the revenue of the Company had about trebled itself, for in 1890 it was £6,080 and in 1895 it amounted to £17,165, while the amount available for interest and dividends, which in 1890 was only £597, was, as shown in the accounts to December 31, 1895, £9,595. The figures for the intermediate period also indicated how the increase of the gross revenue each year had been accompanied by a large increase in the proportion which the net revenue bore to the gross. He moved "that the capital of the Company be increased by the creation of 20,000 ordinary shares of £5 each and that the provisione

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of article 4 of the articles of association of the Company shall not apply to such new shares.'

Mr. E. Garcke seconded the motion.

The **Chairman,** in reply to questions by Major Mackenzie and Mr. Andrews, said it was their intention to give a preference to the present shareholders in allotting the shares, but they did not want to bind themselves and say they would give none to the public. He thought it would endanger their interests to issue a prospectus to the public and then not give the public a chance to take any. A prospectus would be sent in due course to each shareholder, giving notice of the issues.

The resolution was carried unanimously.

A further meeting will be called to confirm this resolution, so as to make it a special resolution.

A vote of thanks to the chairman concluded the meeting.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY, LIMITED.

The report of the Oriental Telephone and Electric Company, Limited, for the year ending December 31 states that the revenue account shows a balance to credit of £8,675, which has been transferred to profit and loss. Including £706 brought forward, there is an amount of £9 381 available for disposal. The license from the Government of Ceylon expired on December 31, the Government refusing to extend it, having resolved to work the telephones through its telegraph department. The Government having declined either to purchase the Company's plant or to compensate the Company for the loss of its business, representations were made to the Government of Ceylon, which resulted in a very inadequate offer being made for the mere value of the plant. This offer the directors declined. The Board then appealed again to the Secretary of State for the Colonies, and ultimately, rather than sacrifice the property of the shareholders altogether, they agreed to accept £2,500, equal to about one-half of the capital expended on the construction. Although the transaction was only completed in January last, the directors are advised that this item in the capital account must be shown in the accounts now presented. The directors, out of the revenue, recommend a dividend of 5 per cent., free of income tax, which will absorb £8,575, and leave £806 to be carried forward. The revenues of the Indian subsidiary companies continue to improve, although the dividend received by this Company are approximately the same as those received in 1894. The expenses of the Bengal Company were temporarily increased owing to a change of manager. The Bombay Company has, after payment of the same dividend as in the previous year, carried to reserve and depreciation undivided profits to the extent of Rs.23,000 The Telephone Company of Egypt has declared a dividend of 6 per cent. as usual on the preferred shares. The China and Japan Telephone Company has had a better year, and the accounts point to an increased surplus after payment of debenture interest. The directors have agreed to extend the time for the payment of the debentures held in this Company, which fell due on December 31 last, for a further period of five years. The turnover by the electric lighting branch in India has more than doubled that of the preceding year, but the expenses incident to sending out an assistant and advertising have again caused a loss on the year's operations. The directors believe there is room for development in this branch, but have deemed it desirable to write off all initial expenses, such as those referred to, which are usually spread over a term of years.

The usual accounts are appended, and the Company's meeting will take place on April 22 at the Cannon-street Hotel.

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

The report of this Company states that "during the year a further sum of £2,906 13s. 7d. has been expended on capital account for mains and meters, and for electrical instruments in the station, the necessary funds having been obtained by loan from the County of London and Brush Provincial Electric Lighting Company, Limited. The revenue account for the year 1895 shows a profit of £230. 2s 1d, as against a loss of £978. 19s. 8d. in 1894, while legal charges in connection with the adjustment of contractors' claims, amounting to £131. 16s. 2d., liability for the greater part of which had been incurred in the previous year, have been paid out of revenue. The total number of lamps connected on December 31 last was equivalent to 5,486 of 8 c.p., being an increase of 1,746 since December 31, 1894, and a considerable additional number have since been applied for and connected in the enlarged area of supply in which mains were laid towards the end of the year. Application has been made to the Richmond Corporation for power to still further increase the area of supply; their consent has been obtained, and mains will be laid during the current year in several of the better residential streets. The machinery and the batteries in the generating station are in excellent working order, and as the capacity thereof is sufficient to meet a greatly increased demand, no further expenditure for plant will be required this year." The total quantity of Board of Trade units generated during the year was 89,698. The meeting of the Company was held on Thursday afternoon at Moorgate-court, E.C., but the Press were not admitted.

Nuremberg.—The Schuckert Company have increased their capital to 6,000,000 marks.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Coventry.—Tenders are wanted by May 12 for boilers, engines, and alternators for the Corporation. Particulars will be found in our advertisement columns

Prague (Austria).—Tenders are wanted by June 1 for an electric lighting central station for the city of Prague. Application should be made to the Stadrath, Prague.

Liege.—Tenders will shortly be wanted in connection with a temporary central telegraph office (about £245). Address, M. le precepteur des Télégraphes, Liège, centre Belgium.

Bruges.—Tenders are wanted by May 13 for the supply and erection of an electric water-level indicator for the River Lys. Particulars from Le Gouvernement Provincial, Bruges, Belgium.

Chapelle-lez-Herlaimont.—Tenders are wanted by May 15 for erecting three lightning conductors on the Hôtel Communal. Address, M. le Bourgmestre, Chappelle-lez-Herlaimont, Belgium.

Elberfeld.—Tenders are wanted by April 20 for the supply of four engines and dynamos and 174 lamps, conductors, etc, for the Prussian State Railways. Address, die Königliche Eisenbahn-Direktion, Elberfeld, Germany.

Sunderland.—Tenders are invited by April 29 for an evaporative tubular surface condenser. Particulars can be obtained from the borough electrical engineer, at the supply station, Dunning-street, Sunderland, on deposit of one guinea.

Bedford.—Tenders are wanted for the supply of vulcanised rubber cables for the Corporation's electric lighting. Particulars can be obtained on application to the town clerk's office, Town Hall, Bedford, and tenders must be sent in by the 21st inst.

Hampstead (London).—The Vestry of St. John's want tenders for a 300-kilowatt steam alternator, feed-water heater, tank, switchboard, etc. Particulars can be obtained from the vestry clerk, at the Vestry Hall, Hampstead, and tenders must be ready by April 27

Chateau Chinon (France).—Tenders are wanted by April 19 for engineering and electrical work in connection with waterworks at Château Chinon, in the department of the Nièvre. The estimate is 43,750fr. (about £1,750), and particulars are obtainable at the Mairie, Château Chinon.

Lisbon.—Tenders are wanted by the Royal Portuguese Railway Company for the supply of articles and material necessary for the upkeep of their electric lighting. Tenders must be sent to the chief engineer, at the company's stores at Santa Apolonia Station, Lisbon, by May 6, and particulars can be obtained there, or at the company's Paris offices, Rue de Châteaudun 28.

Bedford.—Tenders are wanted by the Bedford Urban Sanitary Authority for the construction in various positions in the borough of five underground sub-stations. Plans and specification may be seen at the Engineer's Office, Electricity Works, Bedford, and sealed tenders, endorsed "Sub-Stations," must be delivered at the office of Mr. T. S. Porter, clerk, Town Hall, by 21st inst.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grange town, Yorkshire, to whom the plans, etc., must be sent by May 1.

Lima (Peru).—Tenders for the electric lighting of the city of Lima will be received up to June 1 next at the Peruvian Legation, 13, Comeragh-road, West Kensington, W., where applicants can obtain a memorandum explaining the local conditions. The tenders will be opened and considered by the Municipality of Lima, which reserves to itself the right of selecting that which is most approved or rejecting all if it thinks fit.

Bray (Ireland).—Among other articles, tenders are desired by the Town Commissioners for the supply of carbons, cables, house wires, switches, fuses, incandescent lamps, lampholders, casings, insulating materials, etc. Particulars, together with form of tender, can be obtained on application to Mr. P. MacDonnell, town clerk, Town Hall, Bray. Tenders, which must be on prescribed form, to be delivered to the town clerk, properly sealed and endorsed, by 10 a.m. on 20th inst.

Rathmines and Rathgar.—The Town Commissioners want tenders by April 20 for the electric lighting of the new town hall (about 250 lights, with engine and dynamo), and also for telephones and electric bells. Plans and specifications can be seen at the office of the secretary to the Commissioners, Town Hall, Rathmines, Ireland, or copies will be supplied on payment of 10s., and tenders, in sealed covers, endorsed "Tenders for Electric Lighting," must be sent to the above address by April 20 at 10 a.m.

Hull.—Tenders are required for the supply of coal from May 1 to December 31, 1896, for the Electric Light Committee, in accordance with the conditions set forth in the forms of tender, which may be obtained at the electric light station, Dagger-lane. The contractor will have to enter into the usual form of contract required by the Corporation. Tenders, endorsed "Steam Hards for Electric Light Station," should be sent under seal to the Chairman of the Electric Light Committee, Town Hall, Hull, by noon on 30th inst.

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St. Helier (Jersey).—Persons wishing to establish a lighting station in the locality for the purpose of supplying electric, gas, or other forms of light, for both public and private use, are requested to communicate with Mr. P. Baudains, constable, Town Hall, St. Helier, Jersey. All such preliminary communications are to state (1) form of light—*i.e.*, whether electric, gas, etc.; (2) in the case of electric light, what methods of generation and distribution would be adopted; (3) proportionate price for public purposes and private lighting; (4) general conditions under which tenders would be made. All necessary information will be supplied on application.

Antrim.—The Commissioners for the Control of Lunatic Asylums will receive sealed tenders up to 10 a m. on May 1 for the supply and erection of an electrical installation at County Antrim Lunatic Asylum. The tender should be sent in a sealed envelope, endorsed outside "Tender for Electric Lighting, County Antrim Asylum," and addressed to the secretary, Board of Control, Custom House, Dublin, and should be accompanied by a separate sealed envelope, similarly addressed and endorsed, containing the detailed estimate Forms of tenders, and copy of specification, which has been prepared by Mr. J H. Greenhill, M I E E, will be issued on application to the office of the Board of Control of Lunatic Asylums, Dublin, on deposit of £3, which will be returned to all persons who have sent in bona fide tenders. Plans can be seen at the office of the architect, Mr. John Lanyon, Northern Bank-chambers, Royal-avenue, Belfast.

Shooter's Hill (London).—Tenders are wanted by May 6 for the provision and fixing of electric bells, telephones, fire alarms, etc., at the Brook Fever Hospital, Shooter's Hill, S.E., for the Metropolitan Asylums Board. Copies of the specification form of tender, conditions of contract, and of the drawing, which have been prepared by Prof. Kennedy, LL.D., F.R S., of 14, Old Queen-street Westminster, S.W., can be obtained at the chief offices of the Board on and after 16th inst. upon depositing gold or Bank of England note to the value of £5 (which will be returned only to those who send in a bona fide tender in accordance with the terms of this advertisement, and who return the drawing, specification, and conditions of contract). Tenders, which will only be received on the lithographed form supplied by the Board, must be sealed and endorsed "Tender for Electric Bells, Telephones, etc , Brook Hospital," and must be delivered at the Chief Offices, Norfolk House Norfolk-street, W.C., by 2 p m. on May 6. Unless the tender be accompanied by the specification, conditions of contract, and the drawing it will not be considered.

RESULTS OF TENDERS.

Harrogate (Yorkshire).—The tender of the Liverpool Gas Fittings Company, at £1,293, was accepted for an electric light installation (about 400 lights) including generating plant, also telephonic and bell installations, at the Prince of Wales Hotel.

Sunderland.—The accepted tenders for the plant required at the electric supply station by the Corporation were as follows: for two steam-engines and continuous current dynamos, with steam and exhaust pipes and switchboard extensions, T. Parker, Limited, Wolverhampton; two water-tube boilers of Babcock and Wilcox type. Babcock and Wilcox, Limited, London; fuel economiser, E. Green and Son, Wakefield; a cast-iron tank, H. Tonkinson, Sunderland.

Newtown (Montgomeryshire).—Among the accepted tenders for work in connection with the erection of a factory for Messrs Pryce Jones, Limited, were the following:

L. G. Tate, London, telephones and bells	£48	0	0
Crossley Bros., Manchester, gas-engines, etc., for electric lighting	457	0	0
J. A. Edmondson, Leeds, wiring, etc.	325	0	0

BUSINESS NOTES.

Monmouth.—The Local Government Board have granted the Corporation powers to borrow £8,115 for electric lighting.

Nottingham.—The spacious goods warehouse which has just been erected for the Midland Railway Company is lighted by electricity.

Eastern Telegraph Company.—The receipts for the month of March were £81,135, as against £70,470 for the corresponding period of 1895.

Motherwell (Lanark).—The Police Commission have postponed consideration of the electric lighting scheme, which was estimated to cost £8,500.

Bristol.—The report of the Electric Lighting Committee, which recommends the borrowing of £75,000 for extensions, comes before the Council next week.

Worthing (Sussex).—The Urban Council have in contemplation the erection of public baths, which it is proposed to light by electricity at a cost of £400.

Cupar (Fife).—The Standing Joint Committee have decided to bring the question of the charge for the use of the telephone for police purposes before the County Council.

Train-Lighting.—The North British Railway Company are about to run between Edinburgh and Glasgow an experimental train lighted by electricity on Mr. A. B. Gill's (Messrs. Stone and Co.'s) system.

Western and Brazilian Telegraph Company.—The receipts for the week ending April 10, after deducting 17 per cent payable to the London Platino-Brazilian Telegraph Company, amount to £2,375.

Useful Notes.—We have to acknowledge the receipt from Messrs. Pitt and Scott, 1, Cannon-street, of a copy of "Useful Notes," a waistcoat-pocket companion of information for travellers in Europe.

Cheltenham.—If the experimental lighting in the South Ward is a success, it will be extended to other parts of the town. The dust destructor is doing its duty satisfactorily as a power generator.

Battersea (S.E.).—The question of lighting the Municipal Buildings by electricity has been referred to the Electric Lighting Committee, whose report is expected to be presented at the next meeting of the Vestry.

Portishead (Somerset).—The Urban District Council have instructed the surveyor to make enquiries and report as to the advisability of adopting the electric light. The town has a population of about 3,000

Southend.—Notwithstanding the fact that Prof. Kennedy is preparing a report on the advisability or otherwise of lighting the town by electricity, the Town Council have decided to light the western esplanade with gas.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending April 12 amounted to £1,469, as compared with £1,243 in the corresponding week of the previous year, being an increase of £226.

Llandudno.—The District Council have adopted the report of Mr. A. H. Preece relative to the lighting of the town by electricity, and decided to borrow £25,000 to carry out the scheme, in accordance with a provisional order obtained last year.

Great Northern Telegraph Company.—The net receipts during 1895 including the balance brought forward, amounted to £381,583. The Board propose to pay a final dividend making the total dividend for the year 10 per cent., carrying £58,055 forward.

St. James's and Pall Mall Electric Light Company, Limited.—The sale of electricity for the three months ending March 25, representing the supply at 6d. per unit, amounted to £16,862, as against £13,907 at the same rate for the corresponding quarter of 1895.

Taunton.—The expenditure in the electric lighting department for the year has been £3,004. 13s 3d, and the total income £3,580. 11s. 11d, a profit on the year's working of £575 18s. 8d. The Town Council have decided to borrow £3,000 for additional works.

Chester.—The contractors, Parkers, Limited, Wolverhampton, have commenced operations for the erection of the central-station building in New Crane-street, on the west side of the Holyhead Railway. It is hoped that the electric light will be available next winter.

Parliamentary.—On Tuesday a Committee of the House of Commons passed the Bill authorising the transfer of the undertaking of the Liverpool Electric Supply Company to the Liverpool Corporation. The Bill has now been sanctioned by both Houses of Parliament.

Voghera (Italy).—During the present year the Municipality of Voghera will be ready to consider propoeitions for a system of lighting for the town, either exclusively by electric light or by a mixed system of electricity and gas. The existing contract with the local gas company expires in 1898.

Harrogate.—At the monthly meeting of the Town Council the town clerk reported that he had received the sanction of the Local Government Board for the whole of the loans for the electric lighting scheme, amounting to about £25,000, and he was instructed to press forward the various contracts for machinery, plant, etc.

Electricity and Gold Mining.—The Hesperus Gold Mining Company, Limited, has been formed to work and develop gold mines on the East Coolgardie goldfield. to construct, maintain, and work telegraph and telephone systems, and to carry on in all their respective branches the business of producers of electricity, etc.

City and South London Railway.—The returns for the week ended April 12 were £868, compared with £779 for the corresponding period of last year, being an increase of £89. The total receipts for the half-year terminating as above were £14,339, compared with £14,362 in the same period of the preceding year, being a decrease of £23.

Glasgow.—We are credibly informed that proposals are now being entertained for the construction of several miles of electric tramway in Glasgow on the closed-conduit system for experimental purposes, and in order to show the capabilities of this particular system. Should the results prove as satisfactory as is promised it is expected that there will be considerable developments, not only in Glasgow itself, but elsewhere.

Electric Traction in France.—The work of completing the electric tramways at Angers is being pushed on in order that the opening may take place next month. The Dijon Electric Tramway Company have made a profit of 96,400fr. (about £3,856) on the first year's operations. An enquiry has been held with a view to establishing electric tramways at Limoges, and lines are now in construction at Limoges and Rennes.

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Newmarket.—At the meeting of the Urban District Council a letter was read from the Board of Trade stating that in view of the opposition of the Council to the provisional order sought by the Newmarket Electric Lighting Company it would not be proceeded with.

Swansea.—The Electric Lighting Committee of the Corporation have held a meeting for the purpose of considering an offer made by Mr. J. L. Howell, of Llanelly, to purchase the powers the Corporation have to light the town by electricity. The proposal was fully discussed, but it was decided not to part with the provisional order at present.

Self-Propelled Traffic Association, Limited.—This Company has been registered by Lumley and Lumley, 37, Conduit-street, E.C., as a company limited by guarantee, with an unlimited number of members, each of whom is liable for the sum of £1 in the event of winding up. The control of the business of the Company is vested in a council.

Islington (N.).—The Electric Light Committee of the Vestry have decided to at once increase their plant with a view to extending their system of public lighting from the Nag's Head, Holloway-road, to the Archway Tavern, Highgate, and also for the purpose of supplying the light to the Northern Polytechnic in the Holloway-road and the Agricultural Hall.

Wakefield.—The Mayor stated at the City Council meeting that the County Council had recently made a direct application as to when the City Council would be able to supply their new offices with the electric light; and Alderman Sherwood (chairman of the Electric Light Committee) said they hoped before another year was over to have the electric light in full swing in the city.

Exeter.—The Board of Trade have expressed readiness to consider an application for revocation of the Exeter Electric Lighting Order, 1891, with a view to the purchase of the undertaking under Section 68, and the Town Council have decided to make the application. Sanction has also been obtained from the Local Government Board for a loan of £7,500 for the purchase-money.

Walsall.—At the meeting of the Town Council, the Electric Lighting Committee reported that the number of consumers on March 31 was 53. The committee asked for authority to have the necessary cables, poles, fittings, and lamps for lighting the bridge, Park-street, the entrance to Bradford-street, and Lower Bridge-street laid and fixed at an estimated cost of £621. 10s. This was agreed to.

Indo-European Telegraph Company.—The directors of the Indo-European Telegraph Company, Limited, after adding £10,000 to the reserve fund, have determined, subject to audit, to recommend the payment of a dividend for the six months ended December 31, 1895, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of tax, making in all 10 per cent. for the year.

Eastern Extension Telegraph Company.—For the month of March the receipts show an increase of £6,605 as compared with the corresponding period of 1895 The accounts to December 31 show a balance profit of £210,579, after payment of three interim dividends. The directors propose to distribute a final dividend of 2s. 6d. per share, together with a bonus of 4s. per share (or 2 per cent.), making a total distribution of 7 per cent. for 1895.

Keswick.—At the meeting of the Urban Council the clerk read a letter from Messrs. Hayton and Simpson, Cockermouth, who wrote that they had received intimation that the electric lighting company's application for a provisional order would not be proceeded with or considered. Mr. Mumberson asked if that left a clear course for the Council. The Clerk replied that it would not deter the company from opposing the Council's application.

Paisley.—The Police Commissioners have decided to proceed with a public installation of the electric light. At a meeting in committee it was agreed to ask a tender from the Brush Company for wiring the Clark Town Halls, and after considering the same, it was decided to delay making any recommendation on this subject There was read a letter from Dr. Bottomley to the effect that the cost of a central installation of the electric would be £25,750.

Edinburgh.—The draft provisional estimates laid before the Electric Light Committee of the Town Council showed an estimated expenditure of £20 435, and estimated receipts amounting to £27,925. With part of the apparent surplus it is proposed to reduce the price of the current sold by meter to 5d. per unit. In 1895-96 the estimated expenditure was £13 900. In 1894 95 the actual expenditure was £4,076. 16s 10d. For 1895-96 the estimated receipts were £12,640

Acetylene Gas.—It is stated that the Acetylene Illuminating Company, Limited, of 63, Queen Victoria-street, E.C., who hold a license under the Willson's patents for the manufacture of calcium carbide and the supply of acetylene gas, have made arrangements with the British Aluminium Company by which the Acetylene Company obtain control of the Cowles and various other patents dealing with electrical furnace work so far as the manufacture of calcium carbide is concerned.

Ashton.—The Electric Lighting Committee received 19 applications for the post of electrical engineer, and in their report to the Council they recommended that Mr. S. V. Clirehugh, of Temple-chambers, Brazennose-street, Manchester, be appointed consulting electrical engineer to the Corporation. Councillor A. E. Mellor, in moving the minutes, said the gentleman appointed was a very clever man, and, as he lived in Manchester, he would be able to devote the whole of his time to the work. Councillor Kelsall seconded the motion, and it was adopted.

Ealing.—At the meeting of the District Council the Electric Committee recommended that the system of electric supply should be extended to Gunnersbury, if Mr. L. de Rothschild and the other residents who desired it would pay the interest on the capital charges, a certain sum annually for depreciation, and a minimum of £50 a year for the supply. The surveyor explained that if the proposal were adopted the sum received for the supply would be clear profit. The recommendation was adopted.

Vacancies.—The Blackpool Corporation invite applications for the post of resident working electrical engineer. Applicants are asked to state the salary required, when they will be at liberty, and to forward testimonials to the town clerk (Mr. T. Loftos) before April 27.—An assistant is wanted in the physical department at the City and Guilds Technical College, Exhibition road, South Kensington. The salary is £100, and applicants should communicate in the first instance by letter to Prof. Ayrton.

Price-Lists.—We have received a price-list from the Sunbeam Lamp Company, Limited, of Gateshead on-Tyne, and 50, Fenchurch street, E C. This firm manufactures all kinds of incandescent lamps both for high efficiency and high voltage. The catalogue is well illustrated. We have also to hand an illustrated price-list of electric light requisites from J. Sunderland and Co., Victoria Electrical Works, Halifax. The book gives prices for lamps, fittings, wire, etc., and dynamos and motors up to 42 kilowatts.

Brighton and Rottingdean Electric Tramroad. — The Unopposed Bill Committee of the House of Commons have passed the Bill granting an extension of time until July, 1898, for the completion of the authorised Brighton and Rottingdean Seashore Electric Tramroad. The Bill also empowers the Company to raise £10,000 additional share and loan capital, and provision is made to enable the Company to enter into traffic arrangements with any steamboat, omnibus, and other companies conveying traffic to and from the tramroad.

Belfast.—At a meeting of the Electric Committee the engineer submitted his report on the progress of the introduction and the possibilities of development of the electric light, with an analysis giving the expenditure connected with the production and distribution of current in different forms. He was instructed to examine and report upon sites available for the erection of a main central station, capable of extension and applicable for all the wants of the city for many years hence, in order that, should the Council decide to enlarge the producing capacity of the department, the committee would be in a position to meet the requirements.

Whitehaven.—At the meeting of the Town Council Dr. Hopkinson's report was considered paragraph by paragraph, and it was agreed that the following recommendations in the report be adopted: (1) That a subsidiary switchboard be placed near where the cables now enter the engine-house, and connected to the present main switchboard by bare copper conductors, carried above the iron tiers of the roof; and that Dr. Hopkinson be requested to prepare a specification in order that tenders may be invited for carrying out the work. (2) That disconnecting bars be placed in the present disconnecting boxes for testing purposes.

Bowness-on-Windermere. — At the meeting of the Urban District Council the clerk announced the receipt of a communication from the Board of Trade stating that the electric lighting company for this district had made an application for a further extension of time in asking for a provisional order, wishing it to be extended to October 12 next, and it was required to have the sanction or otherwise of the Council. The chairman saw no cause for any objection whatever, but thought the proper course was to leave the matter with the committee. After a few desultory remarks it was thought they might at once decide that they were quite agreeable the application should stand good.

Leeds.—At a meeting of the Sub-Highways (Tramways) Committee, Dr. Hopkinson attended, and discussed with the committee several matters with a view to the preparation of specifications of the cost of the equipment of the electric tramway system which is proposed between Roundhay Park and Kirkstall. At a subsequent meeting of the Highways Committee the minutes of the Tramways Sub-Committee have been approved, and Dr. Hopkinson appointed as engineer. Dr. Hopkinson will take the full responsibility of the equipment, and he has been instructed to prepare the necessary specifications. Mr. Hewson, the city engineer, has also been instructed to prepare plans for the power station near to Crown Point.

The Church of St. Mary Woolnoth.—Brooke *v.* the City and South London Railway Company came before Mr. Justice Kekewich in the Court of Chancery on April 14. This was a motion by the plaintiffs, the rector and churchwardens of St. Mary Woolnoth, to restrain the defendant railway company from proceeding on a notice to treat under which the company proposed to take the church for the purposes of their railway. Mr. Warrington, Q C, and Mr. R. F. Norton appeared for the plaintiffs; and Mr. Cripps, Q.C., and Mr. Ingle Joyce for the defendants. Mr. Justice Kekewich, by consent, made no order on the motion, except that the plaintiffs should pay the costs of the motion.

Cork.—A special meeting of the City Council will be held to-day (Friday) to consider and approve or otherwise of an application of the Cork Electric Tramways Company Limited, intended to be made to the Lord-Lieutenant in Council, under the Tramways (Ireland) Acts, to authorise the construction, working, and maintenance of tramways in the city of Cork, to be worked by horse power, electrical or other mechanical power, with all necessary works connected therewith, as shown and delineated on

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deposited plans; and in connection with the foregoing, to consider a report of the acting city engineer. The approval or disapproval by the Council of the proposed tramways will have no effect unless it is determined by a majority of not less than two-thirds of the members present.

Derby.—Major-General H. D. Crozier, R.E., has held a Local Government Board enquiry into the application of the Corporation to borrow £13 185 for purposes of electric lighting. Mr. Harris (of the firm of Bramwell and Harris consulting engineers to the Corporation) explained that extensions had to be made at the electric lighting station in consequence of an increased demand for the current by the public. The Town Clerk said that the Local Government Board had written saying that they could not entertain the application for £419 for the purpose of obtaining powers The Inspector replied that the Local Government Board had taken counsel's opinion on the question, and this item was excluded from the present enquiry. Evidence having been taken, the enquiry terminated.

London Tramways.—In reference to the proposal for a tramway trust to manage all the London lines, it appears that the system of mechanical traction to be adopted, if the scheme is carried through, will be an underground electrical one. It is needless to say that prolonged negotiations will be requisite to carry out such a scheme, and in addition a number of private Bills will have to be carried through Parliament to give effect to the proposed amalgamation. The whole idea of the promoters is to place all the tramways of London under one control, and thus effect a network of street railroads which will give greater facilities for locomotion in the Metropolis The County Council's powers of purchase come into effect on most of the principal lines in the course of the next two years, and the idea is that by amalgamating all the lines it will be possible to give the shareholders better terms than they are entitled to under the Bramwell award.

Ayr.—The Town Council have unanimously adopted a recommendation by a committee that the Corporation should construct an electric tramway from Burns Monument to Prestwick, a distance of six miles. From a minute of the Lighting Committee, presented at the meeting of the Police Commissioners, it appeared that the clerk read a letter, dated 12th inst., from Mr. Hammond in reference to the transformers, and the committee directed that the letter be printed and issued to the committee. After discussion the committee were unanimously of opinion that Messrs. Swinburne should be required to fulfil their contract, but as other transformers are required, owing to the extensions, the meeting unanimously agreed to recommend the purchase of five transformers from Messrs. Siemens at the prices quoted in Mr. Hammond's former report. The report was adopted, and it was also decided to purchase 28 meters from the British Thomson-Houston, Limited. The Council's committee have reported in favour of an electric tramway.

Blackpool.—At the monthly meeting of the Town Council Councillor Brodie moved the adoption of the Electric Lighting Committee's report, which provided for the acceptance of certain tenders for the purposes of electrical extension. On the matter of electrical supply to the Winter Gardens, the chairman of the committee, Councillor Brodie, stated that nothing satisfactory had been arrived at between the committee and the company, and the latter intended to put down a private plant of their own before very long. Councillor Sergeneon attacked the committee's new scheme for better supplies and more efficient working, remarking that it was presumptuous to make an application for £30,000 unless they were in a position to assure the Council that the scheme was a thoroughly practicable one. The minutes were passed. A proposal was brought forward by Councillor Brodie for the lighting of Lytham-road by arc lamps instead of gas. Councillor Pagnam seconded the amendment which was carried.

Bradford. The Gas and Electricity Committee have at last decided to light some of the open spaces and more awkward crossings in Bradford with electric arc lamps. The *Bradford Observer* says that for very large spaces where traffic is heavy it has been demonstrated that the electric arc lamp (at a suitable height and properly reflected) is cheaper, light for light, than the best form of gas burner. At the meeting of the Town Council, the Town Clerk (Mr. W. T. McGowen) said that a communication had been received from the Local Government Board intimating that one of their inspectors would come down to Bradford on the 21st inst. to hold an enquiry into the application of the Corporation to borrow £40,000 for the purposes of electrical works. The minutes of the Gas and Electricity Supply Committee, which included resolutions accepting tenders for supplying and fixing machinery and plant at the new electricity works, Valley-road, amounting to £7,543. 10s., and tenders for the erecting of the buildings required, amounting to £11,448. 6s., were adopted.

Hampstead.—Harold W. Woodall has been appointed assistant electrical engineer to the Vestry in the place of W. Bathurst, resigned. The Vestry have accepted the resignation of C. O. Bastian as an assistant electrical engineer, and have authorised the Lighting Committee to appoint his successor. Pipes have been laid down in the High-road, Kilburn with the idea of drawing electric light cables through them when the Vestry decide to light the thoroughfare by electricity. At the last meeting of the Vestry, the Clerk, in reply to a question on the subject of the report on the electric lighting undertaking up to the end of 1895, said that in going through the stock-book at the central-station an error was discovered, owing to which it appeared that there was more of some kinds of material in stock now than had ever been bought. That discovery had caused some delay, but he trusted that the report would be ready by the end of the week. It was resolved to lay an electric lighting main from Alexandra-road to High-road, Kilburn, for the supply of current to private consumers in Belsize-road, at an estimated cost of £462.

Dundee.—At the meeting of the Trades Council Mr. Joseph Carr referred to the allegation made at a previous meeting that the man in charge of the engines and boilers at the electric station was not a practical engineer. He had communicated with Mr. Ballingall, the convener of the Gas Committee, and that gentleman having sent his letter to the engineer in charge of the station, Mr. Walter Brownlee had replied to the effect that two engine-drivers were employed, one of whom was a locomotive driver before he entered the service of the Corporation. The other driver was a mechanic. Both were competent men, and, so far as Mr. Brownlee was aware, it was not usual to employ engineers as engine-drivers at electric light stations. Then, further, Mr. Brownlee said the committee were evidently misinformed as to the cause of the accident which some time ago occurred at the station, as upon enquiry it had been found that the mishap could be attributed to none of the employés. However, the Board of Trade report was expected to be forwarded soon; as it would doubtless be published, the committee would then be able to make up their minds on the point.

Aberdeen.—The Electric Lighting Committee have made an inspection of the electric station in Cotton-street for the purpose of considering as to the extension of the buildings. It was recently decided to add a 300-h.p. engine to the plant, and in a report by Mr. Smith, gas manager, and Mr. Blackman, electrical engineer, issued last week, it was recommended to extend the buildings in view of future increased demands for current. Plans were submitted of the addition to the existing building, the estimated cost being put at £4,590. The committee, after inspection, were convinced that it would be utterly impossible to lay down the new engine in the present floor space, and they unanimously agreed to recommend the extension of the buildings. In the plans it was shown that the two sections of the new block would each afford space for engines with an aggregate of 2,000 h.p. The committee instructed Messrs Smith and Blackman to bring up an additional report showing the exact size of the different engines for which space would be provided. It is recommended that the mains should be extended to supply part of the west end and other districts, at a cost of £10,000

Rathmines (Dublin).—Mr. W. B. Barrington. C.E, representing the Board of Works, has held an enquiry under the Tramways Acts, 1860 and 1871. with regard to the proposal of the Rathmines, Dundrum, and Blackrock Tramway Company to run a line worked by electricity from the Big Lamp, Rathmines, to Dundrum. Mr. William Deverell appeared on behalf of the promoters of the line. Mr. Drury (instructed by Messrs. D. and T. Fitzgerald) appeared for the Rathmines Commissioners and the Pembroke Commissioners. Mr. Dixon, engineer, and Mr. Fawcett, secretary to the Rathmines Commissioners, and Mr. Manly, secretary to the Pembroke Commissioners were present. Mr. Barrington said that the present enquiry was concerned merely with the engineering aspect of the undertaking. Mr. Fuller, engineer to the promoters, was examined, and explained the details of the proposed system. The system of electricity to be used would be the overhead system, and in some places it was exactly similar to that used in the Blackrock and Dalkey line. The wires, however, would not be suspended in the same way as in the case of the line mentioned, but would depend from side brackets affixed to poles. The promoters were quite prepared to lay their line to the satisfaction of the township engineers.

Norwich.—The following report was received at the annual meeting of the Governors of the Norfolk and Norwich Hospital: "The Board beg to report that for nearly two years the subject of the lighting of the hospital, which is unsatisfactory and expensive, has been under their consideration It has been in the hands of two consecutive house committees, who have gone very fully into the matter. They have experimented in one of the wards, and in other rooms, with the incandescent gaslight, and have arrived at the conclusion that, although an improvement in brilliancy upon ordinary gas, it is not suitable for use in the hospital. Finally, they have made exhaustive enquiry as to the cost of installation and of annual maintenance of the electric light, and have found that the former, for an adequate and even liberal system, would be somewhat under £800, and the latter probably less than is annually paid for gas. The Board, therefore, in view of the superior healthiness, cleanliness, and convenience of the electric light, coupled with the fact that part of the gas system is much out of repair, suggest to the governors that it be installed in the hospital, and that the system be connected with the Norwich Electricity Company, by whom they consider it would be advisable, at any rate for a time to be supplied" The report was unanimously adopted. The electric light is becoming very popular in the town.

Guildford.—At the meeting of the Town Council the Paving Committee reported that they had considered the letter of the Board of Trade asking for any observations on the description of the system to be adopted for the supply of electricity by the electric light company, and as the system appeared to be a very usual one the committee had not considered it necessary to offer any observation by way of objection. The committee had also considered the notice received of the intention of the company to proceed with the laying of the distributing mains, and the committee do not see any reason to disapprove of the manner in which this work was proposed to be done. They thought,

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however, that the company should be asked to furnish, on the completion of the works now proposed to be proceeded with, a plan on a large scale showing the exact position of their mains for future reference, and it might be found desirable to obtain the sanction of the Board of Trade to make regulations prescribing the hours during which the undertakers were to have access to street boxes. Alderman Swayne, in moving the adoption of the report, said he thought the Council ought to be very careful with regard to the wires, as they would take up a good deal of the pavement. He thought the company ought to submit plans wherever they were going to take up the pavement before it was done. Mr. Miles seconded, and the report was adopted.

New Malden (Surrey).—It was reported at the last meeting of the District Council that at a meeting of the General Purposes Committee, the clerk read letters from the town clerk of Kingston and Messrs. Trollope (on behalf of of a householder in Coombe) as to the introduction of the electric lighting into Coombe, but the letters were referred to the Council. The Clerk said that was the second occasion on which the town clerk of Kingston had written on the subject, and on the former occasion they replied that the question of electric lighting for Coombe was a little premature. The Chairman said that if they allowed Kingston to introduce the electric light into Coombe it would give them a monopoly for 42 years but by making special arrangements that term might be decreased, and they must bear that in mind. A Member asked how many inhabitants had asked for the electric light. Mr. Monro thought there were several. Mr. Monro moved, "That this Council would be prepared to give permission to the Corporation of Kingston to supply electric lighting to Ward 1 of their district if terms satisfactory to the Council could be arranged." There was no prospect of that Council being in a position to supply the electric light to these people, and they would be acting in the dog-in-the-manger manner if they did not at all events take some steps in the matter. All they needed to do was to protect themselves. Further discussion ensued upon the motion, and ultimately it was altered by Mr. Monro as follows: "That this Council will be prepared to consider favourably the application of the Corporation of Kingston to supply Ward 1 of the district of the Council with the electric light if terms satisfactory to the Council can be arranged." Mr. Salt seconded, and the motion was carried.

Maidstone.—The Urban District Council cannot make up their minds yet to part with their provisional order, although they don't want to use it themselves. At the last meeting of the Council the Electric Lighting Committee reported that Mr. Thomas King had expressed his willingness to alter the terms of his agreement as as follows: (1) To refund all moneys paid by the Council (including engineer's fees and costs), in respect of their order and the transfer of same, not exceeding £750, instead of £500, as originally suggested. (2) That the Council shall be at liberty, on the conditions mentioned in the draft agreement, to purchase the undertaking at the following periods: (*a*) in seven years on paying 30 per cent. for compulsory purchase, (*b*) in 14 years on paying 20 per cent., (*c*) in 21 years on paying 10 per cent. Alderman Ellis moved that the terms of Mr. King be accepted, and, in reply to Alderman Spencer, said if they passed his resolution they would be accepting the heads of the agreement. Mr. Baker seconded the motion, which was supported by Mr. Urmston, who objected to the dog-in the-manager policy of the Council, and maintained that they should dispose of the order to Mr. King and let him carry it out. As a ratepayer he did not want the light, and he objected to pay for it for those who did want it. Alderman Spencer was of opinion that they should not move in the matter at present, and Mr. Cox strongly spoke against the motion, maintaining that the Council should retain the order, although he did not advise them to carry it out at present. He argued that electricity was not properly developed yet, and he noticed that there were orders which had been held for over 10 years by local authorities and never disturbed. Let them wait till they were forced to do something with it. Eventually, the matter was referred back to committee.

Portrush (Antrim).—At the meeting of the Town Commissioners the clerk read a letter from Mr. W. A. Traill, C.E., engineer of the Giant's Causeway and Portrush Electric Railway intimating that he purposed attending the Board's meeting to answer any enquiries in reference to their proposed alteration of their electric system for working their tramway on the overhead system. They intended to erect iron or steel posts on the insides of the pathway, with projecting brackets to carry the conducting wire. At the curve at the Methodist Chapel they would erect an ornamental post in the centre of the triangle between the roads, and place a lamp for gas thereon, allowing a clear headway where crossing the road of 18ft. Mr. Traill was then admitted to the Board room, and explained the details of the scheme He said that at the place where the roadway was crossed he had proposed to give a headway of 20ft. to permit of the passage of vehicles, such as hay-carts, etc., but the county surveyor would be quite satisfied with 18ft. He further explained that the posts would be erected for the most part on the inside of the footpaths, with projecting arms over to the centre of the tram line. The posts would be of drawn-steel tube, 4in. in diameter at the base and 3in. at the top, and the projecting arms would be 1½in. or 2in. in diameter. Suggestions were offered by various members of the Board, after which Mr. Macaulay proposed that the Commissioners approve of the alterations, subject to Mr. Traill's assurance that nothing unsightly would be placed in the streets. He remarked that the through conveyance of passengers from the railway station would be a great improvement, as it would obviate the necessity for the stops and changes which at present occurred at the tramway depôt. Mr. Hetherington seconded the motion, which was agreed to after further conversation. Mr. Traill thanked the Board and withdrew.

Bangor.—At the monthly meeting of the City Council the reports of the Electric Lighting Committee, which were as follow, were adopted: A letter was received from Colonel the Hon. W. E. Sackville West enquiring on what terms the Council would be prepared to supply Penrhyn Castle with electricity from the proposed works. It was resolved that the Council be recommended to construct an electrical main at their own cost for the supply of electricity to Penrhyn Castle, upon Lord Penrhyn giving an undertaking as mentioned in Section 21 of the draft license of the Bangor electric lighting scheme. Tenders for contract Nos. 2 and 3 were opened by the chairman and compared. It was resolved that the whole of the tenders be submitted to the engineer, and that he be asked to tabulate the same and return them as early as possible, together with his observations thereon. Dr. H. R. Hughes wrote stating that he was prepared to give up possession of the land on receiving £10 as compensation. It was resolved that the Council be recommended to accept Dr. Hughes's offer. Dr. Grey Edwards explained the result of the interview the deputation had with the Board of Trade. He stated that the Board of Trade would direct an enquiry to be held at Bangor into the matter. Subsequently a telegram had been received from agents stating that the enquiry had been fixed for the 15th inst. It having been mentioned that the opponents to the scheme intended to be represented at the enquiry by counsel, it was resolved that the question of engaging counsel to represent the Town Council be left to Dr. Grey Edwards and the town clerk with power to act. A deputation from the Water and Gas Committee waited upon this committee respecting a small portion of the land recently obtained for the erection of a gasholder. After a short discussion, it was resolved that the committee, whilst looking favourably upon the application of the Water and Gas Committee, wish to consult their engineer before giving a definite reply. Major Cardew has held the enquiry in connection with the application of the Council for electric lighting powers. The objectors, who included the mayor, were represented by Mr. Griffiths, M.P. Among the witnesses for the Corporation were the Bishop of Bangor, Principal Reichel, Mr. E A. Young (representing Lord Penrhyn), and Messrs. Medhurst and Fawcus.

Coventry.—At the meeting of the City Council, the Electric Light Committee submitted two reports by their consulting engineer, Mr. Robert Hammond. Dealing first with capital expenditure, they stated that the £20 000 sanctioned had been exceeded by a sum estimated at £3,485. The bulk was accounted for by extensions of mains where the demand, actual or prospective, appeared to justify the expenditure, and by purchases of meters, stores, etc.—these accounted for £2,647. Turning to the future, the committee reminded the Council that the original outlay upon generating machinery was reduced to a minimum, while buildings and accessories were of ample size to admit of extension, which it was foreseen must soon become necessary. The additional capital thus expended was, of course, unproductive until generating machinery of corresponding power was installed. The fact that such was already necessary proved that the undertaking was making satisfactory progress. The units of current sold since January 1 were 10,650, which at 6d. per unit amounted to £266 5s. Meter rents and testing fees brought up the receipts to £275. 5s. The expenses for the same period, exclusive of interest and sinking fund, were £303. 8s. 2d. The number of lamps connected had steadily increased, and had the full number been connected from the first the consumption would have been considerably larger. The committee asked for two 30ft. by 8ft. Lancashire boilers, one 200-kilowatt alternator and engine to drive it, one pair high-tension feeding cables from the works, additional low-tension distributing cables, where necessary, additional transformers, with necessary extensions of boiler-house, switchboard, and economiser, steam and exhaust pipes, foundations accessories, and other adjuncts. The cost was estimated at £8,900. They recommended application for sanction to a loan of £13,000 to cover the increased cost of present works and proposed extensions. Alderman Hill, in moving the adoption of the report, said the experience of the electrical engineer was that Coventry had exceeded other towns in its desire to have this light. The lamps connected now numbered 3,612, and it was estimated that during the coming winter there would be between 2,000 and 3,000 more required, making altogether 6,000 lights. As to the generating plant it was proposed to put down, the 400-h.p. engine and the necessary parts connected therewith would cost £5,400, and the gas, transformers, and working would come to £3,500, making an expenditure of £8,900. Mr. West seconded, and remarked that commencing with nine customers and 458 lamps they had on January 1, 1,824 lampe; February 1, 2,299; March 1, 2,783; and April 1, 3,092; with 51 consumers. At the present time there were eight consumers waiting to be connected with 724 lamps, making a total of 3,816 lamps. The report was adopted.

Lambeth.—At the meeting of the Vestry the report of the special committee appointed to consider the proposals contained in the letters of the several applicants for the electric lighting order came up. The committee reported that after long and careful consideration they had resolved to recommend the Vestry to transfer its provisional order to Mr. C. W. Sax on the terms which we published in our last issue. The committee submitted the heads of the proposals by other applicants. Mr. Sydney Morse, on behalf of the County of London and Brush Electric Lighting Company, wrote stating that his company would lay down the mains in the compulsory streets within two years from the grant of the order, and would start with a charge of 7d. This,

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he contended, would be cheaper than the terms quoted by Mr. Sax, which he interpreted to be a request by that gentleman that the Vestry should pay him £1,000 less than they now paid for dust disposal, and give him that which he stated would be a valuable fuel for the production of steam. He (Mr. Morse) hoped that before long the demand for electricity would enable them to reduce the price to 6d., but no company within the Metropolis had commenced to supply at a lower price than 7d., although the more successful companies had, by reason of the demand for electricity within their area, been able to make a reduction. Mr. Stewart Bain, on behalf of the London Electric Supply Corporation, wrote reminding the Vestry that they already held statutory powers under the Electric Lighting Acts in a part of the parish. They were perfectly able and willing to supply whatever demand for electric energy there might be in that part of the parish. He only regretted that notwithstanding the efforts that had been made to obtain business the demand was so scanty. The result of an exhaustive canvass in that part of the parish in which they had statutory powers during the last six years of reducing the price of the current from 7½d. to 6d. per Board of Trade unit, with a sliding scale of discounts to 5d., and 4d. per unit for motive power, and laying about 3,000 yards of distributing mains, was that they had obtained 27 customers. Under these circumstances he respectfully submitted that the Vestry should not at present give assent to any application which might be made by another company to that part of the parish in which they now had powers. He also submitted that it could not be for the advantage of the ratepayers in the district that additional competition should be introduced to that area. Mr. Chalton Hubbard asked whether it would not be necessary to rescind the resolution of the Vestry of September 5 before the report of the committee could be discussed. The Clerk (Mr. H. J. Smith) replied that he had looked carefully through the resolutions passed by the Vestry, and he found that in September the Vestry practically unanimously passed a resolution directing him to write to certain companies, intimating that while not in possession of sufficient information to justify any immediate action, the Vestry had no intention of surrendering the order. He did not think it would be safe to pass an important resolution of this kind transferring the order to any firm unless it were done at a special meeting called for that purpose. He suggested that the matter should stand over in order that a special meeting might be convened. It was unanimously agreed to adopt this course. The secretary of the Lambeth Ratepayers' Association wrote asking the Vestry to receive a deputation on the electric lighting question. There were requests for permission for other deputations, and all these were deferred to the adjourned meeting. Another meeting of ratepayers has been held to protest against the order being transferred. The following resolution was adopted with two dissentients: "That this meeting protests against the proposal of the Electric Lighting Committee of the Lambeth Vestry to hand over to a private individual the provisional order for electric lighting now held by the Vestry, by which action a most valuable asset would be lost to the ratepayers, and hereby asks the Vestry to at least fully enquire into the experience of other local boards in the matter, and also to fully consider the offer of the London Electric Supply Corporation to supply the current at the low price of 2¾d. per unit direct into the Vestry's own mains, by which offer the first cost of the supply would be very largely reduced, and would also enable the monopoly to be kept in the hands of the ratepayers, and thus avoid the payment of large compensation to some company in a few years' time."

PROVISIONAL PATENTS, 1896.

April 7.

7389. Improvements in telephone transmittors. Walter Louis Wilhelm and Byron John Tillman, 45, Southampton-buildings, Chancery-lane, London.

April 8.

7475. Improvements in electrical pilot or shallow water signals for vessels. Henry Harvey Franklin, 40, Chancery-lane, London. (Complete specification.)

April 9

7484. Improvements in electric meters Evershed and Vignoles Limited, and Sydney Evershed, Woodfield Works, Harrow-road, London.

7530. A new or improved electrical alarm apparatus. George Henry Atkinson, 37, Chancery-lane, London.

7556. Improvements in electric railways. Harry Clifton Reagan, jun., 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7557. Improvements in commutator brushes and brush-holders. Robert Hirsch, Maria Rosamunde Hirsch, and James Franklin Trottman, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

April 10.

7588. Electric ram lift. Thomas Meacock, 18, Burlington chambers, New-street, Birmingham.

7621. Improvements in electric switches or apparatus for connecting electric circuits. Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, London.

7622. Improvements in insulating materials and their application to electric wires. Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, London.

April 11.

7649. Improvements in or connected with electric cables or conductors. Henry Edmunds, 47, Lincoln's-inn-fields, London.

7650. Improvements in wire ropes and armourings or coverings for electric cables. Henry Edmunds, 47, Lincoln's-inn-fields, London.

7668. Improvements appertaining to road vehicles propelled by steam, oil, electric, or like motor mechanism. Frank Lister, 56, Low-street, Keighley.

7694. Improvements in or connected with electric traction. Frederick Carleton Esmond, Norfolk House, Norfolk-street, London. (Date applied for under Patents, etc., Act 1883, Section 103, September 11 1895, being date of application in United States.)

7699. Improvements in lamp-posts or holders for electric street lamps and other large lamps. Josef Jakoubek, 433, Strand, London. (Complete specification.)

7716. An improved connection for electric light cables. Robert James Hatton and W. T. Henley's Telegraph Works Company, Limited, 53, Chancery-lane, London.

SPECIFICATIONS PUBLISHED

1895.

5451. Electric meters. Wright.

5892. Regulating electric currents. Hall and others.

7504. Distributing alternating currents. Ferraris and Arnó.

7788. Arc lamps. Ridings and others.

8373. Voltaic batteries. Rawson.

8966. Electromotors. Rowland

9167. Telegraph working through cable lines. Dearlove.

9521. Photographic telegraph recorder. Imray. (Société Industrielle des Telephones.)

9966. Arc lamps. Davis.

22133. Telephone message counters. Hempel and others.

1896.

477. Electric storage accumulators. Stewart.

1654. Voltaic batteries. FitzGerald and Bersey.

1744. Electric traction. Korda.

3682. Electric switches. Siemens Bros. and Co., Limited, and Kingdon.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1½-1⅝
—— Non. Cum., 6 per cent. Pref.	2	1⅝-1¾
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	7¼-7½
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7⅛-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16½-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	12½-13½ xd
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2¼-2⅜
Edison and Swan United Ordinary	3	1⅛-1⅜
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	1⅛-1⅜
—— 7 per cent. Cumulative Pref.	2	2⅛-2⅜
Elmore's Copper Depositing	2	⅛-¼
Elmore's Wire Company	2	⅛-¼
Fowler-Waring Cables	5	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	16½-17½
—— 7 per cent. Preference	10	16½-17½
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	3½-3¾
—— 7 per cent. Preference	5	7⅜-8½
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	103-105
Kensington and Knightsbridge Ordinary	5	8½-8¾
—— 6 per cent. Pref.	5	7½-7¾
Liverpool Electric Supply, Ordinary	5	7¼-7½
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	16⅜-16¾
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	⅝-¾
Metropolitan Electric Supply	10	12½-13 xd
—— 4½ per cent. First Mortgage Debenture Stock	100	118-120
National Telephone, Ordinary	5	6¾-7⅛
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅛-6⅜
—— 3½ per cent. Deb. Stock	100	106-109
Notting Hill Company	10	8¾-9¼
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8⅝
—— £4½ shares	4½	7¼-7⅜
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¾ 5½
St. James's and Pall Mall, Ordinary	5	10-10½
—— 7 per cent. Pref.	5	9¾-10½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	6	8½-8¾
Westminster Electric Supply, Ordinary	5	9¾-10½
Yorkshire House-to-House	5	7-7½

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NOTES.

Islington Central Station.—It may be worth noting that in the issue of April 19 of the *Elektrotechnischer Anzeiger* the first place is given to a description of the newly-erected generating station and works of the Islington Vestry.

Iron and Steel Institute.—For the forthcoming meeting of this institute to be held on May 7, a programme of 10 papers has been arranged. Members desiring to take part in the discussions can have them in advance on application to the secretary.

Liverpool Engineering Society.—The society have arranged visits to the Overhead Railway extension on May 16, and to the National Telephone Company's exchange on June 20.' There are also to be visits to Cambridge on July 3, and to Belfast on July 28.

The Electrophone.—It is stated that an electrophone has been installed in Marlborough House, and last Monday night the Princess of Wales and the Princesses Victoria and Maud were able to hear by its means part of the opera given at Drury Lane, and selections from the performances at other theatres.

Royal Institution.—The following appointments for forthcoming lectures at the Royal Institution are worth noting: Colonel Watkins, on "Chronographs," May 1; Prof. Silvanus Thompson, on "Electric Shadows," May 8; Mr. Alexander Siemens, on "The Amazon Cable," May 15; Prof. J. A. Ewing, on "Hysteresis," May 22; and Prof. J. A. Fleming, on "Electricity and Magnetism at Very Low Temperatures," on June 5.

Acetylene.—Some time ago we noted that the question of the production and use of acetylene appeared to be engaging considerable attention in the North of Italy, and we have now received the first number of *L'Acetilene*, a weekly illustrated review which is to be devoted to the subject. It is a small eight-paged paper published at Milan (Via Cairoli N. 2), and promises to contain contributions dealing with both the practical and scientific sides of the question.

Electrical Volunteers. — It is stated that Dr. Hopkinson's scheme for the establishment of a volunteer corps of electrical engineers has every chance of being carried out. The committee appointed to consider how the electrical engineers could best give their services as volunteers have sought the opinions of electrical engineers in all parts of Great Britain, and a large number of replies has been received expressing a desire to join any corps that may be formed. The committee are now awaiting the decision of the War Office, which it is understood will be favourable.

Stray Currents.—If the Chicago *Electrical Journal* is to be trusted, in St. Louis and other Western cities, people are running motors—no doubt small ones—and getting light from stray currents from the tramlines. The correct thing appears to be to make connections between water-pipes. The most curious part of the business is, however, that while the companies appear to consider themselves at liberty to corrode anybody's water-pipes by electrolysis, our contemporary seriously suggests that anyone utilising the stray current should be punished for "stealing electricity."

High-Voltage Lamps.—The "Review" in a recent issue of the *Elektrotechnische Zeitschrift* is devoted to the discussion at the Institution of Electrical Engineers on Mr. Addenbrooke's paper. The chief points are briefly summarised, and it is noticed, in conclusion, that when it is remembered that, as in a 220-volt installation, each 16-c.p. lamp will take at the most one-third of an ampere, an insulation rule based on 10,000,000 divided by the number of amperes supplied gives an insulation resistance 30 times greater than that prescribed by the safety rules of the Verband Deutscher Elektrotechniker.

Electric Fishery.—According to a note in the *Revista Tecnologico-Industrial*, a patent has been granted in Spain for the use of the electric light for fishing, and a company has been formed which will commence operations at Bilbao and other ports, either working on its own account or granting licenses for the use of its patent, and supplying the necessary apparatus to fishermen in return for a monthly payment. It is known that under certain circumstances a light will attract fishes, but beyond that it is difficult to guess in what way the electric light could be used, and unfortunately no details on the subject are given by our contemporary.

Forcing Plants by Electricity.—The professors in the department of horticulture at Cornell have just concluded important experiments in developing plants by electric light. Prof. Bailey said: "We are highly gratified with the result. We have proved that by using electric light during the daytime we can produce lilies fully two weeks before those that are grown under natural conditions. The effect is fully as marked in the case of lettuce, but we found that electricity is a positive detriment to peas. We will still continue our investigation on different plants, and will ascertain the effects on vegetation of the Röntgen rays. We shall also experiment on plants by electrifying the atmosphere in which they are grown."

The Telephone Service.—At the monthly meeting of the Cardiff Chamber of Commerce on Wednesday there was a resolution proposed by Mr. J. Andrews: "That in the opinion of this Chamber it is urgently necessary that subscribers to the telephone systems of the Post Office and the National Telephone Company in the same local area should be enabled to communicate directly with each other in the same way as can now be done between different areas, and that representations to this end be made by the Chamber to the Postmaster-General and the National Telephone Company." It was, however, decided to urge the Government to buy up the company's system altogether. In reference to the extension of the trunk lines, the Postmaster-General has informed Mr. Gordon, M.P., that he will recommend the erection of a trunk telephone circuit from Aberdeen to Elgin and Inverness.

Crystal Palace Engineering School.—In distributing the certificates to students attending the lectures and classes at the Crystal Palace Company's School of Practical Engineering last Friday, Mr. A. T. Walmisley, M.I.C.E., engineer of the Dover Harbour Board, said that very few people were acquainted with the great amount of educational work carried on at the Crystal Palace. The engineering classes began in 1872 with 15 students, and since that time there had been as many as 100 during the year under instruction. The number at present was 71. That the school had done thoroughly good work was shown by the positions which former students now occupied in various parts of the world. Mr. Rait, the chairman of the Crystal Palace Company, in thanking Mr. Walmisley on behalf of the directors for his address, said that the Crystal Palace in educational, as in other matters, had kept pace with the times.

Corporations and Tramways.—It has been generally believed that Belfast intended to go in for electric tramways, but it is, however, to be feared that the prospects of electric traction there are not nearly so favourable as many have hoped. From what we have

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been able to ascertain, the conditions laid down by the Corporation are of practically an impossible nature, and the entire question is therefore likely to be shelved for the time being. It is understood that, not contented with the safeguard of the Board of Trade rules, the Corporation insist on making the tramway company responsible for all damage to gas and water pipes it is supposed to be caused by electrolysis. On the face of it this does not seem unreasonable, but the clauses would almost certainly be construed so as to cover an amount of ordinary deterioration with which electrolysis has nothing to do. After the Board of Trade has prescribed rules which, according to the best opinions obtainable on the subject, will prevent a thing happening, it is a little unreasonable for a body of non-experts to straightway assume that it is going to take place.

The Steam-Boilers Bill.—A deputation chiefly representative of "labour" interests has waited upon the Home Secretary to ask him to use his influence in pressing forward the Engines and Boilers (Persons in Charge) Bill before the House of Commons. It will be remembered that this Bill got as far as the Grand Committee stage some years ago, but the amendments necessary to make it reasonably workable were such that it had to be withdrawn. On the present occasion Mr. Fenwick stated that the deputation asked that persons in charge of engines and boilers should be forced to satisfy a board of examiners before taking charge of such machinery. The Home Secretary, in reply, said he still required to be convinced that, apart from collieries, such an examination as was suggested would afford any more adequate guarantee against accident than they at present enjoyed. Before the Bill came on in Parliament he would give it his best consideration, but he was not particularly sanguine nor convinced of the necessity for the Bill. Should the attempt to revive this Bill prove serious, it is a matter which will deserve attention on the part of central-station engineers.

The Amazon Cable.—The cable up the River Amazon has been laid and is in a completely satisfactory condition, and the s.s. "Faraday" returned last week to the Victoria Docks after a thoroughly successful expedition. A full account of the laying of the cable, of the obstacles met with, and how they were overcome, is to be given by Mr. Alexander Siemens in a lecture at the Royal Institution on May 15. We have Mr. Siemens's authority for stating that the health of the staff during the expedition was good, and although a few cases of fever occurred the excellent arrangements on the "Faraday" and the other ships employed enabled those cases to be successfully dealt with. For an expedition carried out in so unhealthy a climate in the wet season, this fact alone speaks highly for the organisation of the work. It is interesting to note that besides the cable staff room was made on the "Faraday" for two representatives of the British Museum, so that advantage might be taken of the opportunity which the expedition offered of making an interesting series of investigations into the natural history of the Amazon basin, and it is stated that these gentlemen have brought home a large collection of specimens illustrating the fauna of the primeval forests on the banks of the Amazon.

Electrical Standards.—In the House of Commons on Tuesday, Colonel Mellor, the member for Radcliffe, asked the President of the Board of Trade whether the Board could offer the same facilities for testing and checking electrical standards as are given by the German Government with so much advantage to the German manufacturers of electrical apparatus. Mr. Ritchie, in reply, said the Board of Trade had caused new denominations of standards for the measurement of electricity to be made and verified, and they now had under consideration the best method of affording facilities to manufacturers and others for comparing their instruments with those standards. In reference to this the *Times* remarks that "official tests of electrical standards have not hitherto been made in this country, with the result that British manufacturers requiring certified instruments have been compelled to procure either German goods or English goods certified in Germany. Most purchasers have adopted the former alternative as being both cheaper and less troublesome." It is added that what Colonel Mellor desires is the establishment in England, under the authority of the Board of Trade, of a department similar to that of the Physikalische Reichsanstalt of Berlin, where for a few shillings the finest tests may be applied to electrical resistance standards and all other descriptions of electrical apparatus. The new departure contemplated by the Board of Trade will go a long way in the direction indicated.

City and Guilds Examinations.—The examiners report as follows on the papers sent in last May in the subject entitled "Electric Lighting and Power": "The answers in the preliminary examination show a much higher level of attainment than last year, but candidates generally appear to be very ill-informed about arrangements of circuits. The answering in the ordinary grade is very unequal. The occurrence of batches of consecutive papers with answers of an unpractical or ill-informed kind shows that in a number of cases the classes are being conducted by teachers who are not really electrical engineers, and have no real knowledge of the subject. The sketching generally is poor. In the honours grade, Division I. (electrical instrument making), candidates generally are weak in ability to apply calculations to the problems of instrument design. In Division II. (dynamos and motors) the answers are decidedly poor. Many of the candidates have evidently no knowledge of engineering or of engineers' drawing. It ought to be understood that this branch dealing essentially with the constructive part of electric machinery, the questions will be such as require a certain amount of mechanical knowledge, and especially of engineering drawing. Candidates will be expected to be able to indicate by sketches (sections, etc.), marked with dimensions, what they know of dynamo and motor construction, etc. In Division III. (central-station work, etc.) the answers are more numerous than before, and show a sound acquaintance with the subject. Several papers were really excellent."

Chemistry and the Arc.—Prof. Dewar has been lecturing at the Royal Institution on "Recent Chemical Progress," and evidently considers that the electric arc has had its share in it, and will have a greater one in the future, more especially in the synthetic formation of compounds. Some most interesting results had been obtained, he said, from the electric furnace by the French chemist, Mr. Moissan, in the shape of carbides, stable bodies produced by the combination at high temperatures of carbon with various metals. Many of these carbides were decomposed by water, the hydrogen of the water combining with the carbon to form hydrocarbons. Thus with water, some carbides, such as that of calcium, gave acetylene; others like that of aluminium, gave marsh gas, while others, again, gave these and other gases, and, what was most wonderful, liquid petroleums. It was a curious fact that many years ago Prof. Mendeleief speculated that the only reason for the immense localisation of petroleum at Baku was that it was being generated there—he suggested by the action of water on carbides. His idea was rather smiled at then, but now it was his turn to smile. When acetylene was heated to a dull red heat, it was polymerised to benzene. Benzene was the basis of all the new modern colours, and

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thus by three direct stages it was possible to reach the nucleus of all the colours hitherto manufactured from coal-tar products. First, there was the combination of lime and coke in the electric furnace; second, the decomposition of the carbide thus formed by water; and third, the transformation into benzene of the resulting acetylene by means of heat.

Motorcarts.—The proprietors of the *Engineer* have published the conditions of their 1,100 guineas motor carriage competition, and the Crystal Palace Company will give facilities at the palace for showing the carriages in work there, and for holding the subsidiary trials. The judges will be Sir Frederick Bramwell, F.R.S., M.I.C.E.; Mr. J. A. F. Aspinall, M.I.C.E., chief mechanical engineer to the Lancashire and Yorkshire Railway; and Dr. John Hopkinson, F.R.S., M.I.C.E. The competition is to be international. The vehicles will be divided into four classes, according as they are to carry four or two persons or to convey light or heavy goods, with a supplemental class for an oil-motor car. With the exception of this class any method of propulsion other than muscular power may be employed, provided it be contained in the vehicle. Preliminary runs in the grounds of the Crystal Palace will be made with each of the vehicles in succession by the competitors in the presence of the judges or of someone representing them. The practical working run will consist of a run on the public roads of not less than 100 miles out and 100 miles home, or a total of not less than 200 miles over a course to be announced three days prior to that fixed for the run. It will probably be arranged for Monday, October 12. Any vehicle which does not complete the "practical working run" at a minimum average speed of five miles an hour, to include all stoppages, will be disqualified. The British Motor Syndicate, Limited, has held its first ordinary meeting, and declared a 10 per cent. dividend. At Belfast, the Lord Mayor has presided over a meeting in support of Lord Harris's Act. The London Chamber of Commerce will discuss the subject to-day (Friday).

Institution of Civil Engineers.—In the paper read by Mr. N. G. Gedye on "Recent Developments in Lighthouse Engineering," at the Institution of Civil Engineers, it was pointed out that a marked development had of late years taken place in the direction of reducing the length of flash emitted by lighthouse apparatus to a minimum, and a consequent increase had been obtained in intensity. But in this country the Trinity House Corporation still adhered to the old-established system of long duration of flash, although two sets of apparatus are about to be established at Lundy Island, in the Bristol Channel, revolving over mercury floats, and giving flashes of very short duration. The apparatus now being erected at Cape Leeuwin, Western Australia, gave a flash of one-fifth second duration every five seconds. The apparatus was designed by Mr. W. T. Douglass, M.I.C.E., of Westminster, for the Government of Western Australia, and was an oil light. The powers of oil lights, however, were far exceeded by electric lighthouse lights, there being several of these in France up to 23,000,000 c.p., while there has recently been established at Fire Island, at the entrance to New York Harbour, an electric light of French design and construction of 123,000,000 c.p. This was the most powerful lighthouse light in the world. The old roller-revolving carriages hitherto used for lighthouse apparatus had now been superseded in the case of quick-flashing lights by the ingenious and beautiful arrangement of mercury flotation invented by Mr. Bourdelles, of the French lighthouse service. The whole revolving portion of the apparatus, weighing in the case of Cape Leeuwin nearly three tons, is floated and revolved in a bath of mercury, thus reducing the friction to a minimum. Although the powers of electric lights might be increased to an even greater extent than at present, yet, after all, no light—electric, gas, or oil—was of any use in a fog when that fog had developed into anything denser than a mist. The paper was illustrated by numerous models and diagrams.

Rontgen Radiations.—The strong point of the Americans is practical work rather than scientific theory, and therefore any very serious contribution to an explanation of the Röntgen radiations is hardly likely to come from the other side of the Atlantic. The Franklin Institute, however, has been discussing the subject, starting from a paper by Dr. Houston and Dr. Kennelly, which was mainly a *résumé* of what is known in the matter. The subject is one upon which the merely practical man, if he is wise, holds his tongue. There was, however, on this occasion a considerable number of communications from professors and others. Prof. Elihu Thomson thought the new radiations were extreme ultra-violet waves. Prof. Dolbear and Dr. J. Richards, on the other hand, considered them to be below the infra-red, and Prof. C. F. Himes and Mr. J. Wilson, on the whole, agreed with this, and so did Prof. Snyder. Mr. Outerbridge, jun., advocated the longitudinal hypothesis. If, in America, they favour the infra-red solution, in France, where the theory of light is more studied, the general drift of opinion seems to be in favour of an extreme ultra-violet wave. Mr. C. Henry has advocated this in a paper presented to the Paris Académie des Sciences. When doctors differ, who shall decide? Obviously the competent experimentalist. But until he does so the ultra-violet hypothesis stands the better chance, since there is no limit to the smallness of the wave in that direction, while the advocates of an infra-red theory have to do all their work within known bounds. Although the longitudinal hypothesis no longer occupies the place it did, it is, to say the least, curious that the objection has not been more prominently urged, that if such vibrations are possible in air they must be generated and transmitted in a great many other ways than by a Röntgen tube. When it is attempted to deal with the hypothesis quantitatively, this will bring it into even narrower limits than the preceding one. Only in this case it will be the energy carried, and not the wave length, that is limited.

The Telephone Monopoly.—Mr. J. Henniker Heaton has written to the *Times* on the subject of the bargain between the Post Office and the Telephone Company. "It will be remembered," he says, "that this contract was modestly withheld from an inquisitive House of Commons until it was sealed, signed, and delivered. Then it appeared that the companies were to have a monopoly of telephonic business in the towns for many years to come, while the Post Office was to enjoy the business on the trunk lines between town and town. In other words, to the companies was assigned the oyster and to the public (represented by the Post Office) the shell." The Post Office authorities have provided that in 1911 they should have the right to buy up the companies, but Mr. Henniker Heaton thinks when they come to do it the taxpayer will wear a ghastly smile. "I wonder," he adds, "if they have ever made a rough calculation of what the purchase-money (under the contract) will amount to. I put it at a hundred millions sterling, more or less. Possibly Chancellors of the Exchequer will be a bolder race in the next century. But it may be doubted whether one will be found hardy enough to propose the raising of such a sum (10 times more than we paid for the telegraphs) for any such purpose." Instead of being content to glean after the companies and wait while

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"interests" and "unearned increments" are manufactured, Mr. Henniker Heaton urges that if the Government is really in earnest, and intends to acquire and work the telephones on behalf of the public, it is high time for them to set about the scheme in a businesslike way, without a day's hesitation. "I would therefore suggest," he concludes, "that such members as agree with the views above expressed should communicate with me for the purpose of impressing on Ministers the urgent necessity of dealing with this burning question. Several Ministers are believed to regard the situation with grave apprehension, and doubtless all would be glad to have their hands strengthened by a definite expression of public opinion."

Colour Photography. — There was a very large attendance at Mr. Gabriel Lippmann's lecture on "Colour Photography" at the Royal Institution last Friday. Among the audience were Lord Kelvin, Sir G. Stokes, Sir Frederick Abel, Sir James Crichton Browne, Sir Benjamin Baker, Prof. Dewar, and Dr. Frankland. Mr. Lippmann said of the problem of colour photography, which was as old as photography itself, three distinct solutions had been attempted. In 1840 E. Becquerel converted the surface of a daguerrotype plate into the violet subchloride of silver, and by projecting on it the image of the solar spectrum and other objects obtained coloured impressions. The image, however, was not fixed in the photographic sense of the word, but was blotted out if the plate was exposed to daylight. The second method for colour photography might be called the three-colour method. It could give a very good approximation to the truth, and probably had a great future before it. It was an indirect method, because the colours were not generated by the action of light, but were supplied subsequently by the application of aniline dyes or other pigments. The third and latest was the interference method, which he first published in 1891, and the latest results of which he was bringing forward. For obtaining coloured photographs by this method only two conditions had to be fulfilled. There was wanted, first, a transparent, grainless, photographic film of any kind capable of giving a colourless fixed image by the usual means; and, second, a metallic mirror placed in immediate contact with the film during the time of exposure. A mirror was easily formed by means of mercury. The incident and reflected undulations concurring produced stationary waves, so that it resulted that, whereas in the case of an ordinary photograph the deposit would simply be a formless cloud of metallic particles, in a colour photograph the cloud had a definite stratified form; it was divided into a number of equidistant strata parallel to the surface of the plate and $\frac{2}{10000}$th of a millimetre apart. These being at the proper distance for reflecting the incident colour rays only reflected that colour. A number of photographs taken by this method were exhibited, in which the colours of stained glass and of natural objects, such as flowers and trees, were reproduced.

Incandescent Gaslight. — The Incandescent Gaslight Company, Limited, obtained judgment in Mr. Justice Wills's court on Saturday last against the De Mare Incandescent Gaslight System, Limited, for infringement of the Welsbach patent of 1885. At the same time judgment was given in the action brought against the Sunlight Incandescent Gas Lamp Company, Limited, but in this case Mr. Justice Wills held that the Dellwik patent, which the defendant company proposed to work, was essentially different from what was claimed by the Welsbach specification. He felt that the defendants were taking a very valuable process bodily from Welsbach without any remuneration; but that was the necessary fate of a patentee who confined himself to claiming the aggregate of a whole string of processes. He therefore gave judgment for the defendants upon the issue of infringement. He, however, found for the plaintiffs as to the validity of their patent and reserved the question of costs. As it is practically certain that both decisions will be appealed against, this may be regarded as little more than the first stage of the matter. In connection with this case the *Times* makes some remarks which are equally appropriate to other patent suits: "Dr. Welsbach is not the first, and will not be the last, pioneer to find that others quietly enter into his labours. One reflection is likely to occur to any who has watched the progress of these cases. The substantial question to be determined was one of chemistry and chemical history. The principle of law to be applied was clear and simple. A cloud of scientific witnesses was in attendance, and men of great eminence, such as Sir Henry Roscoe and Prof. Dewar, were called on both sides. The objection to this course is not perhaps very serious when the litigants are wealthy companies and the patent is of great value. But it must strike any impartial mind that the length of such enquiries would be curtailed, that the expert would be more in his true place than he often now is, and that there would be fewer exhibitions of startling conflicts between the opinions of high scientific authorities, if the Court frequently did what it is not customary to do—namely, took the evidence more into its own hands, nominating one expert, or it may be two, to report for its guidance on some of the matters of controversy. An expert reporting as the delegate of the Court would sometimes express himself very differently from one paid for his evidence, and many cases would occupy as many hours as they now occupy days."

The Metric System.—As a sequel to the *Times* articles there has been further correspondence on the subject of the adoption of the metric system, including letters from Mr. G. Johnstone Stoney and Sir Frederick Bramwell. The position taken up by the latter is as follows: "I do not wish to impose English weights and measures and the employment of vulgar fractions on the community. I would make the metric decimal system legal for all purposes, but I would leave everyone at liberty to use that which he preferred." But the practical interest has been taken out of the controversy by what has passed in the House of Commons, where, on Monday, Mr. Arnold-Forster (Belfast, W.) asked the First Lord of the Treasury whether, in view of the fact that the metric system of weights and measures had recently been adopted by Turkey, Russia, and Japan, and was now in use in all the civilised countries in the world with the exception of the British Empire and the United States of America, and in view of the fact that metric measurements had already been adopted with respect to the ton and for all purposes of pharmaceutical dispensing in the United States, her Majesty's Government would take immediate steps to give effect to the practically unanimous recommendation of the Committee on the Metric System, with the object of placing this country on a level with other civilised nations in the matter of weights and measures. To which Mr. Arthur J. Balfour replied: "In answer to my hon. friend, I have to say that the recital of facts in his question is, I believe, correct; but I do not think it would be within the range of practical politics to impose by law on the inhabitants of this country so great a change in their ordinary habits as would be involved in giving effect to the recommendation of the Committee on the Metric System." Mr. Arnold-Forster, however, was not going to allow the subject to drop thus easily and proceeded to ask Mr. Balfour whether he was aware that a Bill for this purpose

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had been introduced into the House of Representatives of the United States, and whether, on behalf of the Government, he would support an amendment of the Standing Orders of the House by which the use of weights and measures of the metric system might be permitted in the case of plans, specifications, etc, submitted to Private Bill Committees? The reply to this was that the American Bill was not passed yet. At present the metric system was illegal in this country, but when the restrictions imposed upon its use were removed it would follow, as a matter of course, that the Standing Orders would have to be altered also. Mr. Gibson Bowles said that contracts could now be legally made in the metric system, but Mr. Balfour thought not, but promised to make enquiry. From this it would appear that nothing more serious is likely to come at present of the committee's report than a "permissive use," in which case it will be a long time before we get a rational system of weights and measures, either decimal or other.

City and Guilds of London Institute.—The report of the council upon the work of the institute for the year 1895, adopted at Wednesday's meeting, reminds us of the loss the institute has sustained in the death of their late chairman, the Earl of Selborne, who from as far back as 1876 took a prominent part in all matters connected with technical education, and who occupied the chairmanship of the institution from its foundation in 1878 up to the time of his death. Dealing first with the report of the Central Institution, it may be noticed that at the close of last session the diploma of associate of the City Guilds Institute (A.C.G.I.) was granted by the council to 37 students who had matriculated and followed one of the three courses as prescribed in the programme of the college—12 in civil and mechanical engineering, 19 in physics and electrical engineering, and six in chemistry. Of the same number of associates who were elected in 1894 it seems that 28 have taken to practical work, and several already hold good positions where the technical training will be of great service to them. The report continues: "The twelfth complete session of the day department of the Technical College, Finsbury, ended in July last, with 210 students in attendance, as against 197 in the previous session, and it is satisfactory to note that this increase has shown itself in the mechanical and chemical departments rather than in the electrical department; for, although the electrical industries of the country have rapidly increased during the past few years, and have consequently opened out a good field of employment for well-trained youths, yet there have not been wanting signs that the market would soon become overcrowded, and that the rush of students desirous of qualifying for employment in electrical works would be checked." The reports on the technological examinations show that the total number attending classes in all subjects was 27,583, an increase of over 2,200 on the previous year. The proportion of candidates who succeed in passing the examinations of the Science and Art Department, and of thus qualifying for the full technological certificate, is still very small; and accordingly the institute has decided to accept its own preliminary examinations in certain subjects, as being better adapted to the requirements of artisans, in lieu of those of the Science and Art Department. It is hoped that this regulation will increase the number of candidates qualifying for the full certificate. One effect of the addition of the preliminary examinations has been to increase the proportion of passes in the ordinary grade of those subjects in which these examinations have been held. The whole report shows that most useful work is being done, and the council of the institute are to be congratulated on the success attending their efforts. Lord Halsbury presided at the annual meeting on Wednesday, when, besides the report mentioned above, there was a proposition from the Mercers' Company for a committee to investigate the expenditure of the funds, the idea being that not enough was done for "those on the lower steps of the ladder." As the requisite notice had not been given with respect to the resolution of the Mercers' Company it was ruled not in order, but the chairman said it could be discussed at a special meeting.

Polyphase in America. — Writing on "Central-Station Working" in the New York *Electrical World*, Mr. H. E. Raymond remarks that in the past four years there have been quite a number of power transmission plants installed in the United States. In these the current used is polyphase alternating, and the voltage employed varies from 2,200 to 3,000 volts. The length of the line varies from three to ten miles. In the installation of such systems, under these conditions, very few "line effects" were anticipated, it being thought that static capacity and possibly resonance would be experienced only on lines of considerably greater length and with the use of a much higher voltage. Practice, however, has shown these effects to be noticeable in systems in which synchronous motors constitute the main portion of the load. In one synchronous motor system, which extends over a distance of but four miles and employs a voltage of 2,500 volts, the static or capacity phenomena were so marked as to be the cause of considerable trouble. This effect was first noticeable in connection with fuse blocks of the magazine principle. These blocks consisted of two fuses in multiple, one being opened about $\frac{1}{4}$in. by means of a thumbscrew. When from any cause the first fuse blew, the current would invariably jump the gap and run on the other fuse. Though quite convenient as an automatic shifting device, it is hardly necessary to state that the life of the fuse block was prematurely short. At each end of the system there was, on each wire, a lightning arrester with a total gap to ground of $\frac{3}{8}$in. At times when the lines were being tested for grounds, a small arc would form from the line through the arrester to the ground, the current returning through the ground detector. If any grounds were in existence on the line the arc in the arrester would, of course, be much more intense. At the same time the current would jump from the ring terminals to the shaft, or from the brush-holder studs through or around the rubber washers to the frame of the machines. This discharge to the ground and frame of the machine nearly always took place at the motor end of the system. During any sultry day in summer there was a likelihood of a discharge taking place through the arresters, and as these were entirely incapable of rupturing the succeeding arc, the arrester was generally repaired by putting up a new one and burying the old. The remedy for most of these troublesome phenomena was the use of what are called "tank" arresters. These have been so arranged that they can be left in connection or cut out at any time, cleaned, and repaired. They are arranged one to each wire entering the station, and if one or two be thrown in and the switch on the other nearly closed, a spark will jump the open space of $\frac{1}{4}$in. to $\frac{3}{8}$in. and continue to do so steadily, showing the continual accumulative charge. Beside using these tanks, marble or rubber guards have been inserted between all exposed points of different potential in order to minimise the danger from current arcing from one to the other. Mr. Raymond adds that in many stations one thing which is the cause of more trouble in alternations of high potential than everything else combined is neglect of cleanliness, and it is surprising how little attention is paid to this important point.

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CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXVIII.

(Specially Contributed.)

Before leaving this historic part of the subject, there is one other experiment described by Faraday in his lecture which may be referred to. He took a coil of wire (Fig. 1), connecting its two ends to the terminals of a galvanometer. He then took "a cylindrical magnet ¾in. in diameter and 8½in. in length." . . . . . "One end of this magnet was introduced into the axis of the helix, and then, the galvanometer needle being stationary, the magnet was suddenly thrust in; immediately the needle was deflected. . . . Being left in, the needle resumed its first position, and then, the magnet being withdrawn, the needle was deflected in the opposite direction"

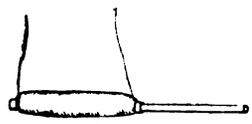

FIG. 1.

A more complete illustration of this apparatus is shown in Fig. 2. If the permanent magnet be rapidly thrust into the coil, we get a deflection of the needle. If the magnet remains in, the needle returns to its point of rest, and on withdrawing it we get a deflection in the opposite direction to that which occurred on its insertion; or if we pass the magnet right through the coil as it leaves the end opposite to that by which it entered, we get a reverse deflection.

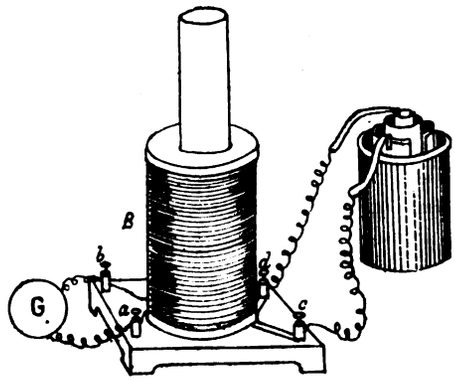

FIG. 2.

More About Lines of Force.—We have seen that all magnets or conductors carrying current exert an influence over the air-space immediately surrounding the magnet or the conductor. The air-space over which a magnet exerts this influence is called its magnetic field. The strength of the magnetic field at any one point depends, so to speak, on the quantity of this influence. Now, we can conventionally agree to measure quantity of influence in one of several ways. That which has been chosen, and is well adapted for the purpose, is the convention of lines through a given area. If we have an area of a square inch at any point, and we suppose *one* line passes through this area while *ten* lines pass through a square inch at some other point, we can compare whatever it is agreed that lines should measure at these points. At one place, whatever is to be measured is 10 times greater than at the other. Now, if a piece of soft iron be placed in a magnetic field, it passes or tends to pass from the point where the influence is weakest to the point where it is strongest—that is, there seems to be a force pulling it in a certain direction, hence we have agreed to measure the amount of magnetic influence by lines, called lines of force. The soft iron would have exerted upon it 10 times the influence when the number of lines of force were 10 to the square inch than it would when the number was but one to the square inch.

Closed Curves.—The direction of the magnetic influence, and therefore of the lines of force that represent that influence, is always to return upon itself; hence each line of force forms a closed curve. As might be expected, the magnetic influence follows the line of least resistance. If the field is in an homogeneous medium, then it may be represented by a number of lines each taking the shortest path left open to it through the medium. No two lines can take the same path. Not only do we conventionally represent the field by lines, and the density of the field at any point by the number of lines per unit area at that point, but we also agree to assume the magnetic influence, flow, or flux, or whatever we like to call it, leaves the permanent or the electro-magnet by the north pole and enters by the south pole. Let us once more examine the lines of force from a bar magnet (Fig. 3). Just at the centre of the magnet the lines do not leave the magnet, but commence to leave just past the centre, and, as shown by the filings, curve round to enter at a distance on the other side of the centre equal to

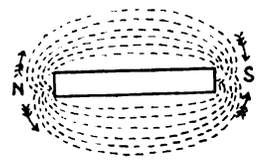

FIG. 3.

that on the side by which they escaped. The greater number of lines seem to leave the magnet near to the N pole and enter it near to the S pole. The whole of the lines pass through the centre of the magnet, hence it is of uniform dimension; the density of the lines at the centre in the magnet must be greater than at any other point—that is, the greatest magnetic strength is just where we in this way see it least. If we take any section through the field the same number of lines pass through that section as through any other section, and will be twice the number of lines through a section of the magnet at its centre. If we assume that magnetic lines of force are, in magnetism, the analogues of current in electrical circuits, we know in the latter case that the same current flows through each point of the circuit. The interior of the magnet may be looked upon as similar to the interior of the battery. The air-space occupied by the field is similar to the external circuit of the battery. The sectional area of the magnetic field differs, however, from that of a conducting wire. The latter is generally fairly uniform at all points, while the former differs considerably at every point. I refer to the sectional area of the external magnetic field—it is smallest near the poles and largest through the point midway between the poles. Roughly speaking, the field of a cylindrical bar magnet must be, when placed in the air, very much the shape of a Rugby football.

Similar quantities have to be dealt with in magnetism as are dealt with in electricity, and a law similar to Ohm's holds good in the one as in the other. We have symbolised the magnetic law thus—

$$L = \frac{P}{R};$$

where L = number of lines of force;
„ P = magneto-motive force (pressure);
„ R = resistance.

Analysis of Pixii's Machine.—The starting point of Pixii's machine for our purpose is the permanent horse-shoe magnet. We may represent this and its lines of force as in Fig. 4. Faraday had just shown that if the lines of force of a magnet were linked or looped around a conducting coil, there would be a current generated in that coil. Pixii, in the first place, provided a less resistance than the air-space for the external lines of force. No doubt he did not see the matter in the same light as we do, and only looked upon his soft-iron core as something upon which to coil his conductor, but his core did nevertheless offer an easier path to the lines of force, and with it our Fig. 4 becomes as Fig. 5, almost all the lines of force going through the soft-iron core, C C. It does not matter whether the core is shaped one way or another, as in Fig. 6, with two arms, C C, and a yoke, Y. Placing a coil upon one or both arms of the core gives us the means of linking or looping the lines of force of the magnet around

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the conductor. One coil of conductor with the lines looped round it would give a certain effect on the galvanometer, two coils would double the effect, three coils treble it, and *n* coils increase it *n*-fold. If we put the same number of coils on each arm we shall find the effect of each set upon similar galvanometers is alike, and joining up the two sets so as to form one continuous set would double the effect upon one galvanometer. So long as you loop the same number of lines around similar coils you get similar results. Suppose N represents

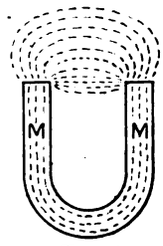

FIG. 4.

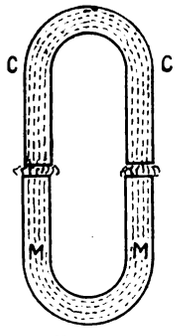

FIG. 5.

the north pole of the permanent magnet from which the lines go through the air-space to the core of the coil through the core and the other air-space to S, the south pole. If we turn the permanent magnet through half a revolution, the N pole will then be under the opposite arm of the core to which it was at first (Fig. 7)—the direction of the magnetic lines will be reversed, and the current in the coil will be reversed. Thus, you will see the current in the coil is reversed twice in each revolution of the magnet—it is alternated. Hence, we call such a machine, not only a magneto-electric machine, because the field magnet, or the magnet producing the field, is a permanent magnet, but an alternating-current machine, because of these periodic reversals of the direction of the current.

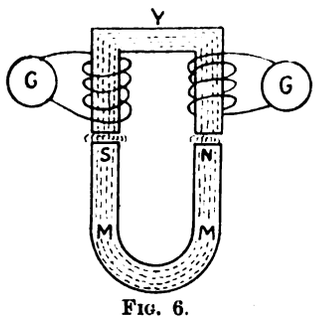

FIG. 6.

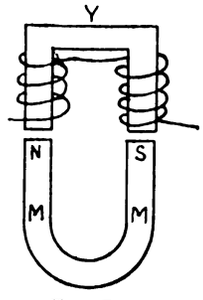

FIG. 7.

The lines of force have another similarity to a current of electricity. We have seen that if a current has the choice of two or more paths, it divides itself inversely as the resistance of the paths; so do the lines of force. Having in this apparatus a path of comparatively small resistance when the poles of the revolving magnet are opposite the poles of the coils, we shall see that this path increases in resistance as the poles are revolved to a maximum when a quarter turn has been made, then decreases again to a minimum when the half-turn is finished. Suppose the magnet to be of very small sectional area, its poles to be represented by the points, S N (Fig. 8). Similarly, the

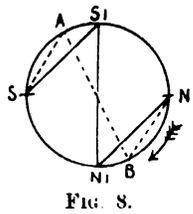

FIG. 8.

opposing core poles may be supposed to be very small, and very close to the magnet poles, so that S N (Fig. 8) may also represent their position. The magnet poles as they revolve describe a circle so that their position at any point during the revolution can be indicated upon the circle described. Suppose now (Fig. 8) the magnet rotated through a quarter of a revolution, the position of its poles may be represented by S_1 N_1 and the distance between S_1 N_1 represents the distance of the air-space between the poles.

Consider two paths only for the lines of force, though in reality there are others, the consideration of which, however, would complicate matters:

1. The direct path from N_1 to S_1.
2. The path from N_1 through air space N_1 S to the end of core just left by N through the core to the end of core at S just left by S and air-space S S_1.

The direct air-space path, N_1 S_1, is always the same, and therefore may be taken to always have the same resistance.

The second air-space path increases as the poles move from the position N S, and is at its maximum when the poles are at N_1 S_1. This path may be represented by the *sum* of the chords $S S_1 + N N_1$. There are two positions in the whole revolution where the two paths have the same length—and therefore presumably the same resistance—and hence when an equal number of lines of force go by each path. Take a pair of compasses, and with distances the radius of the circle from S cut off parts S A_1 and S A, from N cut off N B_1 N B. In the rotation, when pole N has moved to B, then pole S will be at A, and chords N B + S A = diameter = S_1 N_1. Again, when S is at B_1, N will be at A_1, and again sum of chords N B_1 + S A_1 = diameter = S_1 N_1. In these two positions, then, an equal number of lines of force should go by each path. An examination of the diagram will show you how the air-space when measured from the poles to the ends of the core of the armature varies throughout the armature. Of course the total air-space of this circuit is always the sum of two air-spaces. Now, air is a very bad conductor of lines of force; in fact, for all practical purposes, there is only one good conductor—that is, iron. Even iron varies considerably as a conductor of magnetic lines of force. The best Swedish soft iron is perhaps the best conductor of lines of force that can be obtained.

Pixii's machine, then, dealing as it did with so much air-space, was far from being an efficient machine.

Aim of Electric Generators.—The aim of the various electric generators, whether batteries, magneto machines, dynamo machines, or thermo-electric machines, is to transform some other kind of energy into electric energy. In batteries, chemical energy is so transformed; in magneto and dynamo machines, mechanical energy derived from heat energy is transformed; and in thermo-electric machines, heat energy is transformed.

DYNAMO PLANT FOR TELEGRAPHIC PURPOSES.*

The Western Union Telegraph Company has installed in the basement of the Western Union Building a remarkably flexible and complete system of dynamos for supplying current to the numerous lines radiating from its office. The plant consists of three main batteries of dynamos, 19 of which are Edison No. 2 machines of a rated capacity of 110 volts and 40 amperes; two Crocker-Wheeler generators of the same capacity are also used, being machines No. 1 in the positive and negative gangs (see Fig. 1). In addition are used 25 Crocker-Wheeler $\frac{1}{3}$-h.p. 85-volt generators, the use of which will be subsequently referred to. Three New York safety engines of 20 h.p. each furnish the motive power, and in case of accidents, Sprague motors, deriving current from the mains of the Chicago Edison Company, can be instantly substituted for steam power. Two of these motors are of 15 h.p. each, the other one being rated at 10 h.p. Fig. 1 shows the general arrangement of the plant. The positive and negative gangs each consist of eight generators and the spare gang of five machines. The positive gang may, however, be run as the negative gang and *vice versâ*, while the spare gang can be used either positively or negatively, and these interchanges are made daily.

With the positive and negative gangs in operation the first three machines on one side only are used. Taking the

* From the *Electrical Journal* (Chicago).

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machines in their numerical order, No. 1, of 45 volts potential, is used to supply all pony wires within the city limits; No. 2, seven volts, is used entirely in the office for energising single-wire sounders; No. 3, 23 volts, energises the sounders of all multiplex instruments; Nos. 4, 5, 6, 7, and 8 are connected up almost on the principle of the Siemens and Halske multi-wire system, except that one side of the system is grounded (Fig. 2). These five machines, which are duplicated by the five in the spare gang, must be run in sets of two, positive and negative. Nos. 4 and 5 are used to work single and multiplex circuits for short distances. Nos. 6, 7, and 8 are used entirely for multiplex circuits, the voltage increasing with the distance and the resistance.

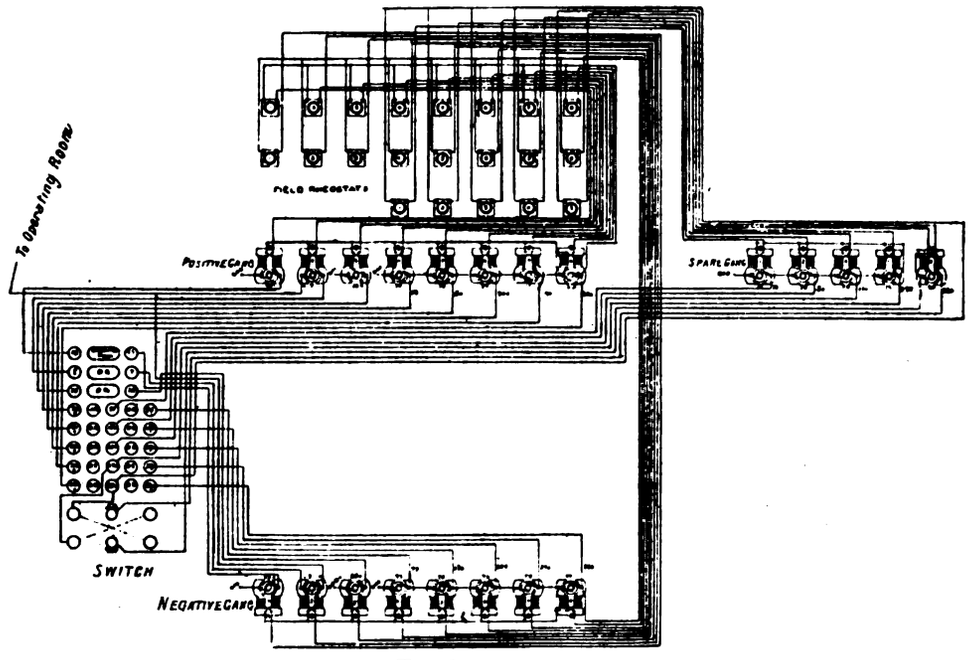

Fig. 1.

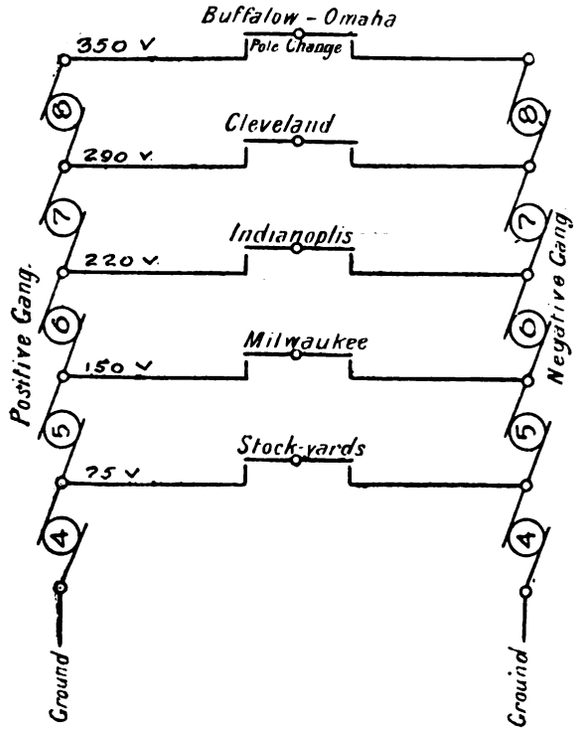

Fig. 2.

The supplementary battery of 25 small Crocker-Wheeler machines is in constant operation, any one of which may, from the switchboard in the office, be thrown into any circuit in lieu of an automatic repeater. For instance, Toledo might call up Milwaukee, and by the insertion of a plug in the switchboard one of these small generators is thrown into the circuit augmenting the voltage, doing away with the set of automatic repeaters, which otherwise would have to be used.

A peculiar feature of the entire plant is that only one generator (No. 8) in each gang is self-exciting, and part of its current excites the fields of all the other machines in the gang through suitable rheostats, and in this way the voltage of each machine is maintained at the figures as shown in Fig. 1, although all the machines are normally rated at 110 volts In addition to this, dynamo No. 4 of the positive gang then in operation energises the fields of the entire battery of 25 small Crocker-Wheeler generators, none of which are self-exciting.

The following table shows the normal load on the plant:

No. 1	45 volts	11 amperes		
,, 2	7 ,,	22 ,,		
,, 3	23 ,,	44 ,,		
,, 4	75 ,,	3 ,,	3 ,,	to line exciter.
,, 5	75 ,,	2·1 ,,		
,, 6	70 ,,	1·25 ,,		
,, 7	70 ,,	2·25 ,,		
,, 8	60 ,,	3 ,,	9 ,,	to line exciter.

The plan of doing away with self-exciting fields enables the operator to maintain the voltage within very narrow limits, and as the total load fluctuates very little a minimum of supervision is needed.

Lines from this office are worked as far east as Buffalo and Pittsburg, in the west to Sioux City, Omaha, and Kansas City, and in the south to Memphis, Tenn.—in other words, within a radius of about 500 miles. Beyond this radius automatic repeaters must be used for points outside.

This dynamo plant replaces a gravity battery equipment of about 60,000 cells, which number could scarcely be closely packed in twice the space occupied by the modern installation, to say nothing of the expense and labour involved in the maintenance of that vast number of primary batteries.

THE BRITISH ALUMINIUM WORKS AT FOYERS.

The British Aluminium Company was formed in December, 1894, with a capital of £300,000. It has a powerful board of directors under the chairmanship of Mr. R. W. Wallace, and includes Lord Kelvin amongst its scientific advisers. As will be remembered by our readers, a spirited correspondence in the public Press resulted from a letter written by the Duke of Westminster last July. We printed these letters in our issue for October 11 last. The statement of the Duke was to the effect that the aluminium works at Foyers would spoil the scenery of the district, and that poisonous fumes would be given off by

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the process which would kill all the trees near the place. If this should have been so, it would be a matter of regret,

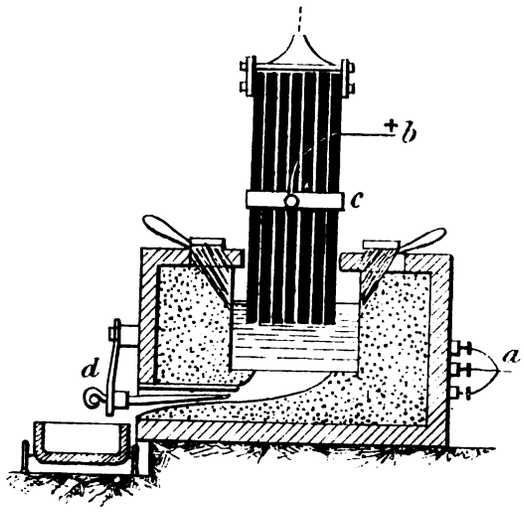

FIG. 1.—Section of the Aluminium Furnace.

although it is doubtful whether the gain in prosperity in the district would not more than compensate the inhabitants. Now the works are almost completed, one can judge as to whether the district will be permanently disfigured. From our illustrations, taken from the road crossing the pipe track, it will be seen that the shore of the loch is fringed by a belt of trees. These trees nearly hide the works from view when the observer is on a steamer on Loch Ness, so that all which can be seen at present is the pipe track. This track up the hillside had to be cleared in order that the pipes might be laid from the power-house to the penstock-chamber, but as soon as this work is completed the surface will be again covered by vegetation. The rest of the work consists of a tunnel to the river above the upper falls. The buildings can, of course, be seen when ascending the road leading to the falls, but as soon as the

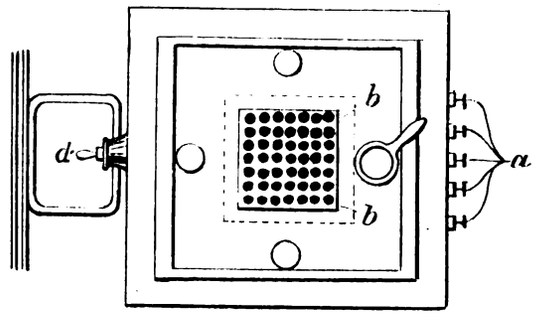

FIG. 2.—Plan of Furnace.

temporary work is replaced by stone buildings of the type shown in our illustration, there will be little in the architectural details that can be objected to by the extreme Ruskinite. As to the effect of the process on the vegetation, the surroundings of the works at Neuhausen, where a similar process has been working for some years, effectually disproves the statement that the trees will suffer.

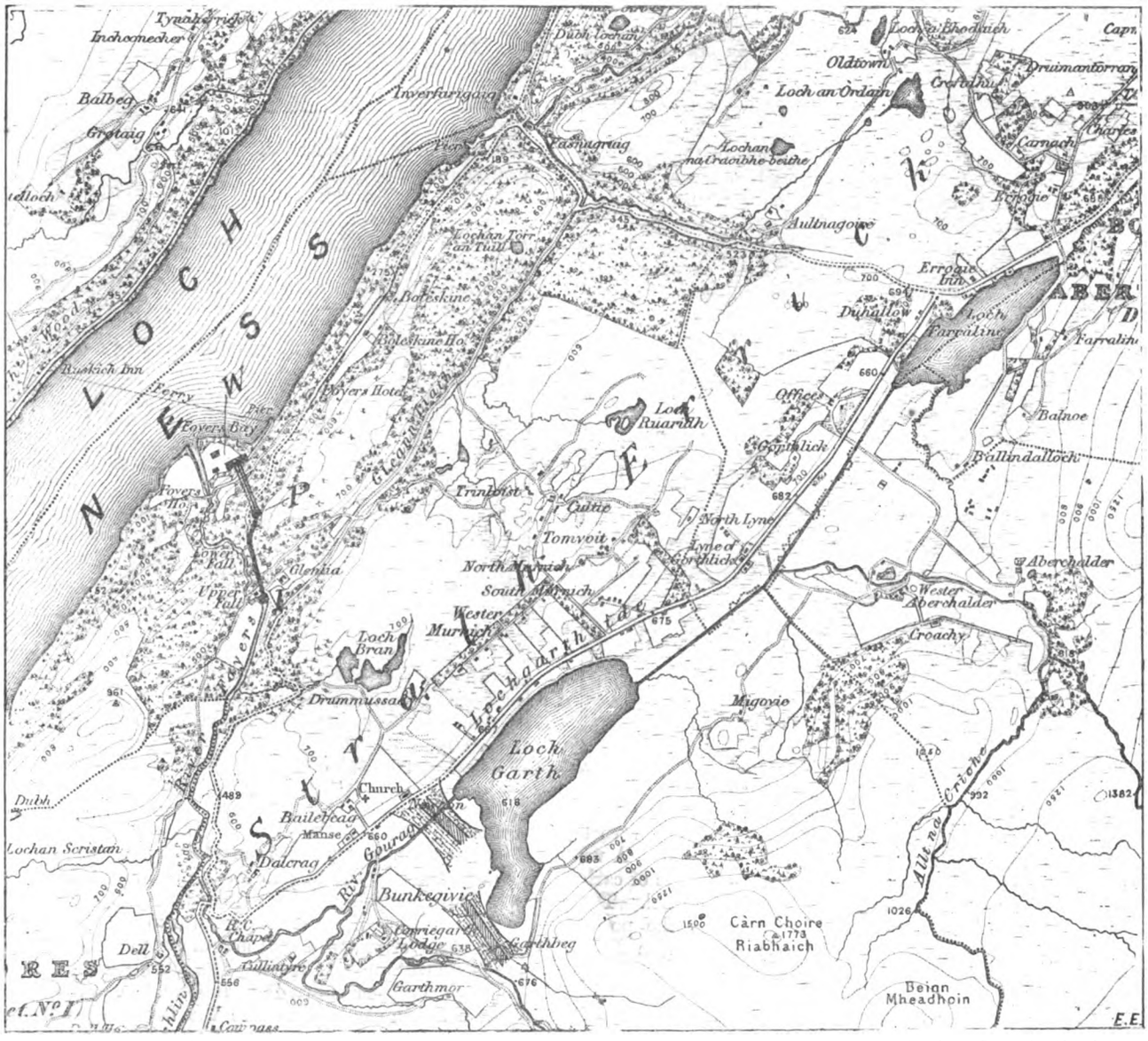

FIG. 3.—Map of the Country round the Falls of Foyers. W, British Aluminium Company's Works. P, Main Penstock Chamber. I, Intake Chamber. The Pipe Line. The Tunnel.

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At Neuhausen the works are picturesquely situated amongst trees on the banks of the Rhine, and a recent photograph shows no signs of the alleged devastating fumes. The material used in the furnace is chemically treated at Larne, in Ireland, where the bauxite is found, so that only pure alumina is imported to Foyers. Hence no superfluous matter will have to be discarded at Foyers, and the heaps of *débris* expected by the enraged lovers of nature will not be formed.

The reduction of the aluminium will be effected by the Herault process, in which the purified alumina is melted and decomposed by the electric current. A carbon anode and a copper cathode are used if it is desired to produce aluminium bronze, but a copper cathode is not essential. With a carbon cathode pure aluminium can be produced. For this purpose the fusing and reduction take place in a rectangular iron vessel lined with carbon, which is connected to the negative terminal by copper leads, *a*, in Fig. 1. A wide aperture in the top of the vessel allows a bundle of carbon rods, *b* in the diagram, to descend into the vessel. These serve as the anode, and are connected to the positive terminal. The apparatus is shown in section in Fig. 1, and in plan in Fig. 2, from which the construction of the anode and its position in the cell is clearly shown. The bundle of rods forming the anode is hung from a balancing weight, so that its position can be easily adjusted. A copper frame, *c*, holds the carbons in their place, and at the same time forms the means of connecting-up with the cable conveying the current. At the commencement of the operation a very small quantity of copper is placed at the based of the carbon rods and melted by the arc. The alumina is then added, and electrolysis takes place under the influence of the current, the oxygen going to the carbon and forming carbonic oxide gas and the metal going to the bottom of the chamber. If pure aluminium is desired, as is the general rule, only alumina is added, and after the first lot is run off practically pure aluminium is obtained. The metal is run off into moulds from time to time, and fresh material supplied as is required. It is important that the alumina should be chemically pure. It is obtained from bauxite. The bauxite is heated with caustic soda, but not to a melting temperature, and the aluminate of sodium is extracted by water, the silicates, iron, etc., remaining behind. The alumina is precipitated by carbonic acid, washed, and dried.

The Works at Foyers.

The area from which the water is collected is a most extensive one, and a large part of this land has been acquired by the company. The water right also gained will allow them to construct the necessary works for storage of the water now running to waste in times of heavy rainfall. The question of the regularity of water coming to the falls is one of great importance to the company, and also to the tourists, who still may hope to enjoy a sight of the renowned Falls of Foyers. The scheme prepared by the company's engineer is briefly as follows. A fair proportion of the water in the river above the falls comes from the valley containing Loch Garth and Loch Farralin. As will be seen in the map, these lochs are some two miles apart, but there is little doubt but that originally they formed one large loch. The action of the stream has, however, scoured out a bed in the hard rock where it leaves Loch Garth, and so lowered the level of the water. The land now exposed between the two lochs consists mostly of a low-lying swamp, the difference in water-level

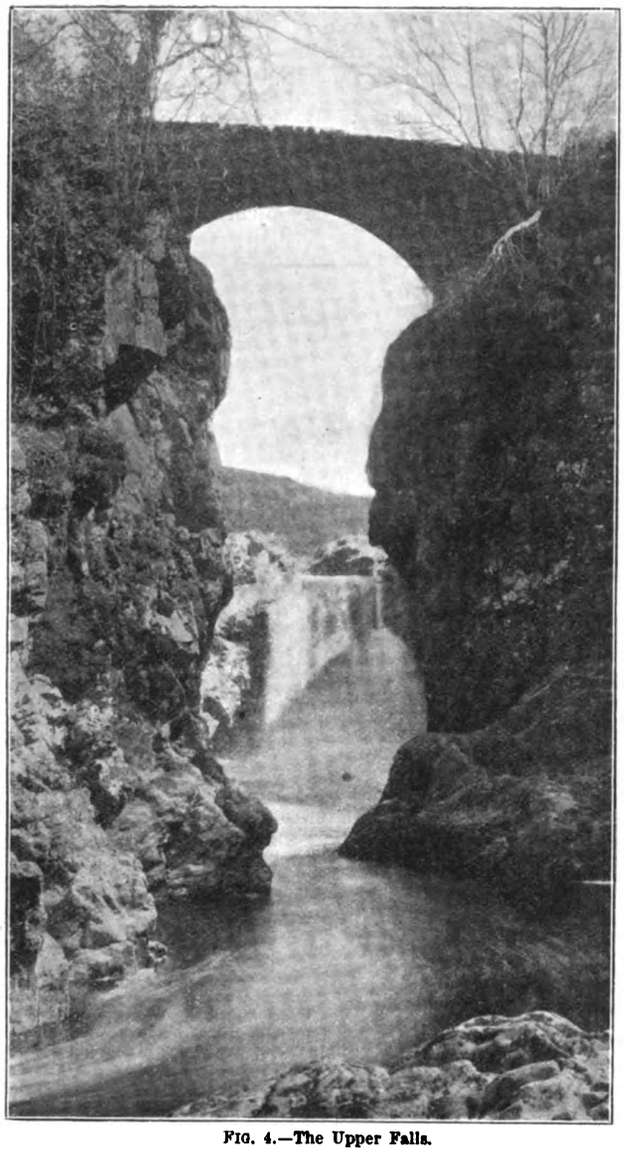

FIG. 4.—The Upper Falls.

FIG. 5.—The Lower Falls.

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between the two being only about 10ft. The engineer proposes to build a weir and a dam at the lower end of Loch Garth, as indicated diagrammatically in the map (Fig. 3). The weir is placed across the small valley through which the River Gourag flows. The dam is required to fill in a slight depression in the formation in order that the new water-level may be attained. The land in the centre, between the weir and the dam, is sufficiently high to admit of the water-level rising some 20ft. This new level will submerge the whole of the land between the two lochs, and will form one large reservoir 4¾ miles long. The breadth will be also much increased, and the water-level where Loch Farralin now is will be raised by 10ft. In this large reservoir a vast quantity of water can be stored in the winter, and it will also collect the heavy spates in summer, which now swell the falls to an enormous extent for a short time. The heavy falls of rain cause the river at the point where the intake to the tunnel is placed to rise by an almost incredible amount, a rise of 7ft. in two hours being a not unfrequent occurrence. Such large volumes of water would be useless to the works, and it is expected that the reservoir will provide sufficient storage to supply both the works and the falls in times of drought. The area of the water basin draining into the falls is unfortunately outside the Scotch districts of exceptionally heavy rainfall, being situated rather too far eastward to catch the moisture brought inland from the Atlantic Ocean. The rainfall, however, averages about 40in. per annum, which is no inconsiderable amount. All the surveys have been completed for the weir and dam, but the construction of the masonry work has not yet been commenced. The normal flow of the river will suffice to work at least half the plant at present installed. The River Gourag takes the water from Loch Garth to the River Foyers, the length of this river being about two miles. The upper falls are about 1¾ miles below this junction. The intake to the tunnel is situated in a pool just above the falls. The penstock is of circular form, and is built of granite, of which there is an abundant supply on the estate. It has five gates, so that the water can be conveniently regulated. Connection will be made to this point by telephone, so that the man in charge can quickly shut off the water entering the tunnel in case of need. The tunnel between this point and the main penstock-chamber on the hillside above the power-house is about half a mile long. The tunnel is, roughly, parallel to the river gorge for the greater part of the distance, and a number of headings from the gorge are driving into the tunnel line. From these the spoil is discharged down the side of the gorge. The nature of the formation can be gathered from the views of the upper and lower falls (Figs. 4 and 5). The whole of the tunnelling had to be carried out through rock varying in nature from a mica schist to a hard limestone. The diameter of the tunnel is 8ft. throughout, and for the greater part of its length it is lined with concrete. The length next to the intake from the river is through such hard rock that no lining is deemed necessary. The majority of the headings are permanently closed, but in some cases a discharge pipe is inserted, by means of which the tunnel can be drained for inspection. The slope of the tunnel is very slight, as the section allowed is ample for the flow required, and consequently there is little loss of head between the intake and the main penstock-chamber. The construction of this tunnel has been carried out by Welsh miners working night and day since the autumn, and the hard nature of the formation has necessitated a liberal use of dynamite.

The main penstock-chamber is situated on the hillside, directly above the turbine-house, to which it is connected by a series of cast-iron pipes laid down the slope of the hill. The chamber is built on the rock, and is constructed of granite lined with concrete. It is rectangular in form, and of ample dimensions to form a settling-tank. The provision for excluding drift and rubbish at the intake is, however, likely to prevent much deposit being laid down.

FIG. 6.—View of the Works and Part of the Pipe Track at Foyers.

Provision is made in the wall facing Loch Ness for seven pipes of 30in. diameter and one smaller pipe. Two of these large pipes are now being laid, and two are completed ready for running. The diameter of the pipe is reduced by two steps to 20in. at the turbine. Sluice-valves are placed at the point at which the pipe leaves the penstock-chamber, and again at the turbine. At the upper end of the pipe line an inspection-chamber is provided in each pipe, which also gives air relief. The effective head obtained is over 350ft. A view of the pipe track showing the pipes in the trenches is given in Fig. 6, which also shows the main building, containing the generating plant and the aluminium furnaces. The land just beyond this building is flat, so that the trees on the shores of the lochs form a screen in front of the works. The photograph from which the illustration was made was taken from the public roadway.

The smaller pipe is to be used to supply two 50-h.p. turbines, which will be used for lighting and transmission of power purposes. It is proposed to light the hotel and the few other houses near, and perhaps eventually the model village to be erected for the employés will also be lighted electrically.

(To be continued.)

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CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

A PLEA FOR COMPOUND ARITHMETIC.

SIR,—As you have mentioned my writing, many years ago, against the French decimalism—which I still regard as barbarous and retrograde; but I have quite abandoned the system I then proposed to substitute—and my objections thereto apply equally to his duodecimals (or, indeed, rather more so), a few lines may suffice, I think, to explain the reason for compound arithmetic, which seems now quite misunderstood. Simple arithmetic consists in repeating a particular base upward and downward, and the most natural base is the number of our fingers. Hence have arisen the names hundred, thousand, myriad (now disused in English prose), million, billion, etc. The Hindoos have a far greater number of these. It is natural to extend any such system, and especially when some better base than 10 is taken. Twelve is a far better base, for the reasons Mr. Halliday explains. So is 8, which Charles XII. of Sweden wanted to introduce, but not so good as 12. But a far better than 12 is 60, which the ancient Babylonians really used, and which survives to our day in the divisions of hours of time, and of degrees of angle. This is what I ventured to revive (in the pamphlet he mentions) and to apply, as he would duodecimals, as a new simple arithmetic, to which all measures and weights would have to be adjusted. But I did not perceive, at that time, why simple arithmetic was justly modified into compound, and that compound arithmetic, except among savages, must prevail.

One line in Mr. Halliday's article (p. 430) gives the reason: "For the purposes of the engineer, it must be subdivided and multiplied by a number which admits of the highest form of sub-division." Exactly so, but powers of a number, of 10 or 12 or any other, will never admit "of the highest form of sub-division." This will be plain if we begin from 6, the lowest number that has two divisors (besides 1 and itself), and construct the series of what I would call *eumetric* numbers, each having more divisors than any number below itself.

6	has	2	divisors	1,260	has	34	divisors	55,440	has	118	divisors
12	,,	4	,,	1,680	,,	38	,,	83,160	,,	126	,,
24	,,	6	,,	2,520	,,	46	,,	110,880	,,	142	,,
36	,,	7	,,	5,040	,,	58	,,	166,320	,,	158	,,
48	,,	8	,,	7,560	,,	62	,,	221,760	,,	166	,,
60	,,	10	,,	10,080	,,	70	,,	277,200	,,	178	,,
120	,,	14	,,	15,120	,,	78	,,	332,640	,,	190	,,
180	,,	16	,,	20,160	,,	82	,,	498,960	,,	198	,,
240	,,	18	,,	25,200	,,	88	,,	554,400	,,	214	,,
360	,,	22	,,	27,720	,,	94	,,	665,280	,,	222	,,
720	,,	28	,,	45,360	,,	98	,,	720,720	,,	238	,,
840	,,	30	,,	50,400	,,	106	,,	1,081,080	,,	254	,,

The rule in school arithmetics called *Practice*, and the tables often added, called "practice tables," the "aliquot parts of a pound," or "of a ton," etc., show exactly the object for which the diverse weight-tables and measure-tables were devised. The blunder of their inventors was in making them *diverse* at all. Each trade got a fancy that certain habitual quantities, manloads or cartloads, were best for its own business, and each thus created its own table—"wool weight," "ale measure," and so on. But money being common and national, the coins were fixed nearly on the very best. The excellent "practice table" of a pound or £, arises from the number of pence in a £ being 240, one of the above eumetric figures. "Troy weight," being derived from the same Latin source as our money, has the same excellence in its numbers. But if we now turn to "avoirdupois" weight we find no 12, no 240, nor any of the figures in the above table. The 16oz. are not eumetric in themselves, though the ratio occurs between 1,260 and 20,160. Again, 2,240, the number of pounds in a ton, has but 26 divisors, or fewer than 720 has. Again, take our long measure: the mile is 380,160in., having but 142 divisors, the same as 110,880. So far are we from admitting "of the highest form of sub-division." On the other hand, in money, our largest coin (now out of use) was the five-guinea piece, of 2,520 halfpence, or 5,040 farthings, both numbers being in the eumetric table.

It may be observed there is one square eumetric, 36, and no other, and we can easily prove that no cube or higher power can ever enter the series. But I regard it as quite essential to a proper compound arithmetic, that the largest unit in each measure should be 720,720 times the smallest. Hence, it is not necessary for square or cubic measures to be numerically square or cube. The above number might result from a solid 88in. by 90 by 91; or it might, in land measure, be a surface, 840 × 858. Our present acre is not a square of any lineal measure. It is 22 yards by 220, or 44 by 110, or 55 by 88. The supreme number of every system being 720,720, this will be reached best by six steps of 7, 8, 9, 10, 11, 13. But it does not follow that they should be in this order, nor whether they should increase upward or downward. Above the largest, and under the smallest unit, we shall go decimally, and therefore it might be well to put the 10 at one end of the scale, making it, perhaps, 10, 9, 8, 7, 11, 13. But all these details I leave for discussion, the sole points now insisted on being the extent, and total figure 720,720.

In using the British foot, we must remember, it is also Russian and Swedish; and all the higher Russian units already multiply it by 7, as all the British do by 11. And it has two singular connections with 1,001, which Sir J. Herschel noted in his essay "On the Yard, etc." He had reasons for suggesting its increase by one-thousandth; but the same purposes would be served by merely multiplying by $7 \times 11 \times 13 = 1{,}001$. A remarkable natural fact, to be kept in view, is that the longest degree on earth exceeds the shortest as 100 to 99. Degrees and minutes are perhaps the very last kind of measure we may expect to change

To show that Halliday's duodecimals have no advantage, on page 432 he says, "The present second is one 86,400th part of a day, and the new second would be one 248,832nd." Well, 86,400 has 94 divisors and 248,832 has but 64. The latter has fewer than 10,080 has, the former has as many as 27,720 has. Such is the inferiority of *any* simple arithmetic to compound!—Yours, etc., E. L. GARBETT.

THE METRIC SYSTEM.

SIR,—Allow me to correct a statement made in your issue of to-day which may mislead your readers. At page 425, under the heading of "The Metric System," you say a metric ton weighs 2,204lb. approximately. This is only true when applied to distilled water at a standard temperature and pressure. The accepted weight of the cubic metre or ton for coal is 900 kilogrammes, or, say, 1,984lb., in France, and, if I remember right, 905 kilogrammes, or, say 2,000lb., in Spain. The great difficulty in correctly stating the weight in relation to bulk lies in the fact that coal of different classes runs in different sized pieces, and in other respects varies. Custom, therefore, has determined that the cubic metre or ton of coal in France should be taken as 900 kilogrammes.

The habit in French ports is to sell coal to English ships in tons of 40 cubic feet, and to French ships in 900-kilo lots of one metre cube. I can with safety venture the opinion that if the metric system were not maintained by law in France it would die a natural death.—Yours, etc.,

London, April 17, 1896. ROBERT KAYE GRAY.

THE INSTITUTION.

SIR,—Referring to the anonymous letter which we are astonished to see appearing in your issue of the 17th inst. on the above subject, we desire to state, in reference to the late presidential election, that the conclusions of your correspondent in regard to the Brush Company's officials are to our knowledge absolutely without foundation.—Yours, etc.,

R. S. ERSKINE.
ALFRED E. MAYOR.
April 20, 1896. A. A. C. SWINTON.

[We are glad to insert the above authoritative letter, but at the same time must point out that the views held by our correspondent are the views held extensively by many who have held aloof from or opposed the agitation connected with the Institution. Similar views were expressed to us before the election of president and council, and our correspondents (Messrs. Erskine, Mavor, and Swinton) ought not to be astonished at our giving effect to views so widely held. Surely it is but just that both sides should be heard.

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As yet the opposition has had the talking and writing pretty much its own way, but from what we hear there is a limit to be made in what so many members have ventured to think approaches to personalities. The Institution is not a battle ground for splenetic exhibitions, nor should the lobby of the theatre be used as a canvassing ground by the friends of the agitators, as it undoubtedly has been. If Mr. Raworth was actuated solely in the interests of the Institution and had no mental reservation whatsoever in his criticisms of the balance-sheet, those criticisms could have been succinctly and clearly put in less than five minutes.—ED. *E. E.*]

SAFE v. DANGEROUS ELECTRIC LIGHT CURRENTS.

SIR,—As I have always from practical experience contended that electric light and power can be more efficiently and economically supplied to towns and urban districts within a radius of five or six miles by using continuous currents than high-pressure alternating currents, I was, to settle as far as possible the question of danger, impelled to write to the Board of Trade for information.

To my letter of enquiry they have courteously replied as follows: "In reply to your letter of the 9th inst. I am directed by the Board of Trade to state that they have been informed of nine cases of fatal accidents to employés at generating or transforming stations where high-pressure alternating currents are used, but that no instances have been reported in the case of low-pressure continuous currents."

As the information received is of great public interest I trust you will see the desirability of making this known to your numerous readers.—Yours, etc., A. L. FYFE.

[We would be glad if Mr. Fyfe will give us figures from his practical experience of supplying towns within a radius of five miles by low-pressure continuous-current plants, as we do not know where this has been done. We also point out that no deaths are reported to consumers on the high-tension systems, and that the nine deaths to employés would have been reduced more than 50 per cent. if the victims had obeyed their instructions and used the precautions provided. We might suggest to Mr. Fyfe that in his disinterested labours for the safety of the public he should take up a crusade against the use of water for drinking purposes, as owing to the number of deaths recorded from drowning, it must be a most deadly fluid.—ED. *E. E.*]

THE LOCOMOTIVE BILL.

SIR,—The Light Locomotive Bill which was recently introduced in the House of Lords is of such vital importance to the electrical industry that perhaps you will find space for the following.

Mr. Chaplin received the deputation headed by Sir David Salomons on February 12, after which I had an interview with him, and I wrote to him at length on the following day. I need not, however, trouble you with my letter of that date or Mr. Chaplin's courteous answer. When, however, on March 30 we were able to obtain a copy of the Bill I wrote to Mr. Chaplin a letter, copy of which I enclose, together with his reply. I am glad to be able to add that on Tuesday last Mr. Chaplin and Lord Harris did me the honour of receiving me at the Local Government Board. I found them most anxious to do all in their power to meet the reasonable requirements of all the industries interested in this particular Bill. They, however, are of opinion that it is essential some restriction should be placed on weight, as otherwise they fear that heavy traction engines will be run about the country and through our towns at a considerable speed. I am glad, however, to be able to add that though they were not able until after consulting with their technical advisers to determine the exact limit of weight that the Government may think necessary, yet I have no doubt when the Bill is read a second time in the House of Lords we shall find, instead of two tons, if not five, at any rate four tons will be substituted. Mr. Chaplin said that this is a matter of experiment, and that the Government, while most anxious to assist the industries connected therewith in every possible way, felt that until some experience was gained on the subject they must be very cautious. Electrical omnibus traffic can certainly be conducted with success with a weight of five tons, and I have very little doubt that even if we are restricted to four tons, we shall be able to do very well with this traffic in our London streets and in other towns.—Yours, etc., S. FLOOD PAGE.

[COPY.]

LOCOMOTIVES ON HIGHWAYS.

102, St. George's-square, S.W., April 1, 1896.

Sir,—I have the honour to remind you of the interview which you accorded me after you had received the deputation on the above subject, on February 12, together with my letter of February 13, and the answer of your secretary thereto. I am afraid that in the multitude of the business connected with your department you have overlooked your kind promise to bear in mind my representation as to the vital importance to the electrical industry of not limiting the weight of the omnibuses or carriages to be used in towns to two tons. I may state that this limit, which is unfortunately contained in the Bill, has created great consternation amongst those connected with the electrical industry. It was only the day before yesterday that we were able to obtain a copy of the Bill, and I have already received communications from several of the leading representatives of electrical work, suggesting my writing to the papers, holding meetings, etc. I have, however, such confidence in your promise as to feel assured that such public agitation will not be necessary. If this limit is maintained it will practically exclude the use of electricity for horseless omnibuses, though it is undoubtedly the safest, cleanest, and best for such carriages.

On Wednesday last I was speaking at the meeting of the Associated Chambers of Commerce as one of the council of the London Chamber, and, remembering your promise that you would bear in mind my representations on this subject, I stated that we might look forward to this Bill with complete confidence that there would be no restriction put on horseless omnibuses not found necessary with the existing omnibuses, and no unnecessary interference with the natural development of the electrical industry as applied to omnibuses, etc., in towns. Judging from the welcome this announcement received from the delegates of the Associated Chambers, I have no hesitation in saying that if it had entered into my mind that this prohibitory restriction of weight would have found place in the Bill, I should have been able to get a resolution passed unanimously asking you to withdraw your present limit, if, in fact, you thought it essential that there should be any limit whatever, or any restriction beyond that for street traffic in London at the present moment. You are aware that laden wagons of 16 tons are now legally permitted to traverse our streets, while the large three-horse omnibuses, weighing very many tons, are allowed the free use of the Paris streets.

This question is one of such absolutely vital importance to the electrical industry, which, as you are aware, has been most seriously hampered in this country by what is now recognised as erroneous legislation, that I do hope you will be able to remember your most kind promise to give effect to my representations, and that you will prevent the agitation which must immediately be excited if this most lamentable, unnecessary, and unjust restriction is maintained in the Bill.

Naturally, I will not ask you to see me with one or two other representatives of the industry during the short Easter holidays, but I shall be most glad if, before any public meeting is called, you would see me with one or two representatives of the electrical and carriage-building industries, so that if possible the necessity for this agitation may be done away with.—I have the honour to remain, Sir, your obedient servant,

(Signed) S. FLOOD PAGE.

To the Right Hon. H. Chaplin, M.P., etc.

[COPY.]

Local Government Board, Whitehall, S.W., April 2, 1896.

Dear Sir,—Mr. Chaplin desires me to reply to your letter on the subject of the Light Locomotives Bill.

The Bill has been introduced in the House of Lords in consequence of the pressure of other business in the House of Commons.

The question of the weight of the articles to which the Bill is to apply is a matter of detail, and Mr. Chaplin is perfectly ready to receive and consider suggestions on the subject, which is a new one to all concerned, and of which there has been so little practical experience.

He has forwarded your letter to Lord Harris, who has charge of the Bill in the House of Lords, and from whom your suggestions will, he is sure, receive every attention.

When the Easter holidays are over Mr. Chaplin will be very willing to see you, in company with Lord Harris, or to receive in writing any further statement on the subject which you may like to submit.—Yours faithfully,

(Signed) H. C. MUNRO.

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MUNICIPAL ELECTRICAL WORK.

It is with great pleasure that we reprint a paper and discussion from our contemporary the *Journal of Gas Lighting*. In the first place, we know that we have here in a condensed form the animus of the gas world against electrical progress. In the second place, we have concentrated into a small space all the facts, figures, and arguments which seem satisfactory and conclusive to the gas working world. We are glad to take up some of the points raised by this paper and discussion, though a detailed examination of the same would be impossible in the space at our command. The first point is rather of an abstract character, and may well lead to diversity of opinion. What class of work ought to be municipalised? We have long since come to the conclusion that in sanitary matters, in the provision of water and of light, among other things, the municipal authorities should reign supreme. The provision of light is for the common good, and, properly provided by the local authority, it can be provided initially and maintained more cheaply than by any other means. When carried out by other parties, the extra initial cost and the extra annual cost is a tax upon the community for the benefit of strangers, which the community ought not to bear. From these and other reasons we have always contended that there could be but one answer to the abstract question as to the proper authority under which to instal and distribute artificial light materials. In his paper Mr. Troughton deals with certain facts, and takes great credit to the gas company for things over which the gas company has no more control than has Paris of Troy renown. The increased demand upon a gas company is not due to the company's work, but is the result of the growth of surrounding population. When it is claimed as something good and beneficial that 10, 11, 12, and 12½ per cent. dividend is paid in respect of a gasworks, we contend it means that the gas company reaps what it has not sown, and mulcts the commonalty of that money which it has neither worked for nor deserved. If the expansion of trade depended upon the merit or the work of the company, it would be another matter. It does not. The building of houses has nothing to do with the company, nor has the agglomeration of population. In our opinion, the declaration of huge dividends and the appreciation of value of shares in this class of concern is a discredit rather than a credit, and points to the absolute necessity of getting rid of obnoxious monopolies. What crass stupidity must exist if anyone imagines the giving of money to a town in such a case is unaccompanied by a more than corresponding giving to the company. Neither small nor large towns are being rushed into electric lighting schemes. They have been quiescent too long, and are beginning to see that the incidence of rating and paying of other folk's dividends may be ameliorated by taking this work into their own hands. The discussion brings out other amusing points, not the least suggestive of which is the careful suppression of facts and the gleeful production of exceptions. The introduction of any big industrial revolution cannot be accomplished without failures. Such failures can always

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easily be accounted for, and it does not redound to the credit of opponents to try to make it appear as if the failures were the rule and successes the exception. Mr. Dixon probably thought he scored a point by referring to Cowpen and its failure, but how far his conclusions are discounted by the phrase "to lay down a proper installation," he forgets to say. A boy with a bent pin does not expect to catch salmon like a well-equipped angler, nor do you expect to succeed with an "improper" as with a "proper installation." Further, does it not go without saying that people must not overlook the fact that with increased consumption electrical energy can, as well as gas, be supplied at a cheaper rate? A point raised by Mr. Barton is just as misleading when he compares the candle-power cost of a big gas lamp with the candle-power cost of a little incandescent lamp; why did he not compare his gas candle-power cost with that of an arc lamp? Electrical engineers are tarred with the same brush, and too often make misleading statements by comparing things that ought not to be compared. The last point to which we will call attention is another relating to comparisons—the comparison of cost and returns from a small electrical installation in its early days with the cost and returns of matured gasworks. These figures, to be just, should relate to works comparable in size and being in full working order. However, we should have little to fear from an unbiassed examination into the results of central-station working; but our remarks on this point must be deferred. It may be well to mention that, so far as Newmarket specially is concerned, the electrical question did not arise as between the local authority and the gas company, but a private company, strongly supported, wished to instal electricity at Newmarket, and the authority was called upon to come to a decision whether it was advisable to allow this private company to enter upon the work or to undertake it themselves. We think the decision to undertake it themselves was the best possible.

THE NATURE OF CHEMICAL CHANGE AND THE CONDITIONS WHICH DETERMINE IT.*

BY DR. ARMSTRONG, F.R.S.

(Continued from page 440.)

Probably no discovery could be made which would be of greater technical importance than the discovery of a method of burning fuel electrically—*i.e.*, so as to produce electricity instead of heat. Hydrogen may be burnt electrically in the manner discovered by Grove, apparently because it is possible by means of platinum to connect both hydrogen and oxygen in circuit with an electrolyte such as diluted sulphuric acid; but we have not yet succeeded in discovering a method of "plating" a conductor with carbonic oxide which would enable us to arrange it in a circuit with oxygen. If this could be done, probably the problem would be soon solved. In the case of solid fuel the problem presents other difficulties, especially that arising from the want of suitable electrolytes: thus, although heated lead oxide is readily reduced by carbon, it does not behave as an electrolyte when the attempt is made to burn carbon electrically by means of it, the action being purely local. In like manner we have to discover a means of converting nitrogen into either ammonia or a nitrate comparable with that which apparently enables the papilionaceous plant or associated bacteroid to assimilate nitrogen from the atmosphere.

Having broadly laid down the principle that chemical changes consist in the exchange of ions, and therefore take place exclusively between ions, the "ionists" may be presumed to accept the view that chemical and electrolytic changes generally are synonymous operations. This being the case, it is remarkable how little has been done by way of applying the hypothesis except as a means of correcting values obtained in working with solutions which behave as electrolytes. The expansion and application of Faraday's conceptions to the explanation of chemical change generally appears indeed to have been retarded rather than advanced by the assertions formulated by the advocates of ionisation as a precedent cause of chemical change; indeed, Faraday's writings appear to have received no notice from the school. No attempt has been made to differentiate electrolytes from dielectrics by explaining either the essential peculiarities of either class or the co-ordination of composition—*i.e.*, structure and function—or to explain the extreme readiness with which dielectrics are in many cases acted on, or to define the conditions under which chemical change will occur; or to explain the readiness with which a minute amount of "impurity" will often condition change.

Whatever hypothesis be adopted, the determination of the essential qualities of an electrolye—a correct answer to the question, What is an electrolyte?—is of fundamental importance. The electricians would say it is a substance which, whilst conducting, undergoes decomposition, which is a purely practical definition. The "ionists" say that it is a substance in a state of ionic dissociation; but theirs is a dissociation of a most mysterious kind—confined to a very limited number of substances—affecting members of the same group in a most arbitrary manner, as whilst some respond others do not to the call to ionise on entering into solution—in no way to be co-ordinated with their relative stability as determined by any ordinary chemical method—and conditioned by the agency of a solvent which, though by hypothesis a mere screen, yet exercises a most potent influence, at solvents generally besides this one have little if any action. I discussed the question tentatively at Aberdeen, but did not arrive at any satisfactory conclusion as regards compounds which, *per se*, act as electrolytes. Facts have since come to light which make me more hopeful. In the case of the metallic protochlorides, so many of which are electrolytes, whilst the corresponding perchlorides are not, electrolysis involves the chloride acting both as electrolyte and "chlorine depolariser," and it is conceivable that the occurrence of decomposition is dependent on and in a measure conditioned by the depolarisation—in other words, that separate molecules are conjointly influenced by the E.M.F., and that while under it the one molecule promotes the decomposition of the other. The readiness with which the silver and lead haloïds undergo electrolysis may be explained in a similar manner, if it be assumed that they are capable of exercising at least a temporary affinity for halogens. It is remarkable that the elements from which electrolysable haloïds are derived occur closely together in the periodic system, and it may be said within the section of the alkali metals. As the alkali metals form tri-iodides, and similar compounds have been obtained from silver haloïds, as well as tetra-haloïd compounds of lead, there is reason to believe that the power of attracting halogens here postulated is actually existent, especially at high temperatures, when the fundamental molecules may be supposed to be more or less free from mutual control, and more likely, therefore, to form compounds with other elements.

From this point of view the behaviour of silver haloïds and of other substances which act as simple electrolytes is strictly comparable with that of composite electrolytes, as I have termed conducting mixtures of dielectrics; and if such a view could be accepted the phenomenon of electrolysis would appear to be strictly comparable with those of chemical change; both would occur within complex molecular systems. The behaviour of aqueous solutions on electrolysis may conceivably be more analogous to that of haloïds than is commonly supposed if it should turn out, for example, that in the case of solutions of sulphuric acid in water the first products of electrolysis are, as I have tentatively argued (compare *Proceedings*, 1893, 190), hydrogen and *persulphuric acid*. As I will show later on, it would not be difficult to apply a similar hypothesis to other acids and generally to aqueous solutions, especially if water be the *significant* substance in all these changes.

In discussing this, it is necessary to consider the acids themselves, as the suggestion here made in a measure involves the conception that acids such as sulphuric acids are hydrates, not hydroxides. Without attempting to discuss this matter in detail, I may say that, in my opinion, there is no evidence which in any way obliges us to regard sulphuric acid as $SO_2(OH)_2$; on the contrary, all the arguments are equally compatible with the assumption that it is a compound such as may be represented by the formula $SO_3 \cdot OH_2$, in which the radicles SO_3 and OH_2 are still preserved. There is no reason why such a view should not be extended to all "inorganic" acids, and if it be assumed that solutions of the halhydrides contain hydrates, the behaviour of such solutions as acids is strictly comparable with that of acids generally. Organic acids are peculiar in so many ways that they may well also be peculiar in their constitution, and different from those derived from elementary oxides.

* Presidential address delivered before the Chemical Society.

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If sulphuric acid be a hydrate—viz., $SO_3 \cdot OH_2$—persulphuric acid is probably $SO_3 \cdot O_2H_2$,* and the formation of the latter during electrolysis as the primary product would, in a sense, involve the oxidation of water, so that the change would be similar in form to that which I have supposed to occur when a silver haloïd is electrolysed. By thus extending the view that electrolysis is the outcome of the combined action of the E.M.F. and of some effect which the one set of molecules exerts upon the other set while both are under the influence of the E.M.F., a clearer conception is gained of the possible nature of the effect which the one set of molecules exercises on the other set. The peculiar value of water as a solvent is also in a measure explained.

As regards the differences observed between acids, I have elsewhere pointed out in a note on the formation of salts (Chem. Soc. *Proc.*, 1891, p. 118), that "it may be supposed that in all cases the acid and the base in the first instance combine, and that the salt is formed by subsequent interactions within the molecule. In like manner, acids form dissociable compounds with water, and it is by the occurrence of change within such systems under the influence of an E.M.F. that electrolysis is effected. In those cases in which the compound is highly unstable and prone to dissociate, the opportunity for change to take place within the system is but slight, and consequently the acid is a weak one, and its solution of relatively low conducting power."

The argument here used would apply equally to alkalies and salts, although it may be doubted whether dissolved salts as such promote electrolysis; it is not improbable that they are more or less hydrolysed, and that the products condition electrolysis. On this assumption the conductivities of salt solutions afford a measure of the extent to which hydrolysis has taken place in them.

Experience shows that action at once necessarily takes place so soon as a conducting circuit is established, provided that the sum of the changes be exothermic—thus, copper readily dissolves in cold dilute sulphuric acid if coupled with platinum in nitric acid, or in presence of oxygen, although the heat of dissolution of copper in sulphuric acid is negative. This principle is one of extraordinary importance, and I desire to draw attention to one illustration of its application which I believe to be of consequence. It is well known that Baeyer in 1870 pointed out that the resolution of glucose during fermentation into alcohol and carbon dioxide, and, indeed, the phenomena of fermentation generally, may be accounted for by the assumption that translocation of hydrogen and oxygen atoms is induced through the alternate separation of the elements of water and their addition in different order, changes which would involve the accumulation of oxygen atoms at certain parts of the molecule, thus constituting points of weakness where disruption of the molecule would inevitably occur. This is shown in the following formulæ, in the second of which the separating elements are indicated by dots:

I.		II.		III.
$CH_2 \cdot OH$		$CH_2 \ldots OH$		CH_2
$CH \cdot OH$		$C \cdot OH \ldots H$		$CH \cdot OH$
$CH \cdot OH$		$C \ldots OH \ldots H$		$C(OH)_2$
$CH \cdot OH$	→	$C \cdot OH \ldots H$	→	$C(OH)_2$
$CH \cdot OH$		$C \cdot OH \ldots H$		$C(OH)_2$
$CH(OH)_2$		$CH \ldots (OH)_2$		CH_2

It will be seen that in the product of rehydration (III.) the terminal groups are fully reduced, whilst there has been an accumulation of OH groups in other parts of the system. In a molecule so constituted, changes might then set in similar to those involved in the resolution of oxalic acid into carbon dioxide and formic acid.

The conception is one of remarkable beauty, and undoubtedly a sufficient explanation, as changes precisely similar to those attending fermentation may be effected by simple hydrolysis: thus glucose may be converted into lactic acid by heating it with alkali; and on boiling fructose with muriatic acid an acid is formed—*i.e.*, lævulinic acid—$CH_3 \cdot CO \cdot CH_2 \cdot CH_2 \cdot CO_2H$, the production of which clearly involve a reduction of some of the $CH_2 \cdot OH$ and $CH \cdot OH$ groups, and oxidation of others, in the manner pictured by Baeyer. The only difficulty is to account for the occurrence of such changes under the conditions prevailing during fermentation, and here Baeyer has left the problem unsolved.

I have already drawn attention to the manner in which, perhaps, enzymes promote the hydrolysis of glucosidic compounds. A slight extension of the hypothesis appears to be all that is required to afford an explanation of the changes attending fermentation. Such changes are known to occur entirely within the cell, and are, presumably, functions of the protoplasm—in other words, they probably occur within very complex molecular systems of extreme instability; perhaps under the influence of, in contact with, the very same hydrolyst (enzyme) which, when separated from the cell, is so active in promoting the hydrolysis of cane sugar; or, if not, of substances of a similar nature. On inspecting Baeyer's formulæ it will be noticed that during rehydration the elements of the water molecule become added on to non-contiguous carbon atoms, and this is not improbably frequently a special feature of such changes. Supposing that the protoplasmic hydrolyst were to condition the formation of a conducting circuit in which any two of the carbon systems ($CH_2 \cdot OH$, $CH \cdot OH$, or COH) of the glucose molecule and water molecules were included, if the total hydrolytic change which could take place in such a circuit were exothermic, even if the change affecting the one group involved an expenditure of energy, water would be electrolysed, and its hydrogen would effect the withdrawal of OH from the one group and its displacement by hydrogen, while oxygen would be added to the other group, it may be directly, or in consequence of the displacement of H by OH. The different effects produced by different organisms, on this hypothesis, would be the consequence of the hydrolysis affecting different systems. As most, if not all, fermentable compounds are asymmetric, and the enzymes are undoubtedly also asymmetric bodies, the direction of attack would depend on the character of the asymmetry of both hydrolyte and hydrolyst (for nomenclature see *Trans.*, 1890, 528), and only compatible hydrolysts—*i.e.*, those compatible with the hydrolyte—would condition hydrolysis and fermentation. I venture to think that the hypothesis here put forward not only affords a sufficient explanation of the occurrence of change in the manner suggested by Baeyer, but is also of value as indicating a process by which the "energy" which is in defect in one part of a complex molecule may be supplied from another part, a point of some importance, as E. Fischer's marvellous researches on the carbohydrates and similar compounds clearly prove that the several groups of which the carbon atoms are centres in such molecules are practically independent systems which require to be individually influenced.

Considerations such as these may obviously be applied to all cases of chemical change in which complex asymmetric compounds are concerned, and are possibly of wide application in explanation of the chemistry of vital processes, including those of disease and death.

The introduction of new elements into the circuits within which normal changes occur, even if these were to remain conducting, would necessarily condition some variation in the rate, if not in the character, of the change, and even neutral substances would interfere and affect the rate of dissociation (hydration), for it is probable that the systems under consideration are eminently unstable. The interposition of non-conductors would cause "death" within the circuit affected, and hence indirectly in others. The effects produced by alcohol are, perhaps, explicable from this point of view.

In the case of vital processes, it may be pointed out that one great distinction which apparently may be drawn between actions taking place under "vital" conditions and those effected in the laboratory arises from the circumstance that in the former case a number of changes of distinct types may more often take place, if not simultaneously, at least in rapid succession, affecting different and, it may be, distant parts of a molecule. It would seem that while included within the protoplasmic molecule, in some cases also protection is afforded to that part of the molecule which if free would be the first to suffer, as in the case of the oxidation of glucose to glucuronic acid, for example, the attack being consequently directed into unusual channels, and that in others molecules are brought into association and caused to interact, which under ordinary conditions would fail to affect each other.

Whatever the nature of "protoplasmic" molecules, they must be of extreme complexity, and, consequently, they must present very many active regions to which other groups may become attached and within which therefore circuits can be established; hence the marvellous power of protoplasm of conditioning a great variety of changes; and it is doubtless the marvellous complexity of the albuminoids which renders such diversity of type possible in both the animal and vegetable kingdoms. Protoplasmic molecules may indeed be likened to a huge modern manufactory within which a great variety of operations are being carried on—almost all, in fact, that are necessary for the production in its finished state from raw materials of the particular article manufactured; many of the operations go on independently, others consecutively and dependently; yet all are carried out under one guiding impulse, within one sphere of action.

It can scarcely be doubted that the truth of Faraday's doctrine of the unity of chemical and electrolytic change will ere long be generally recognised now that it has been shown in so many cases that interaction does not occur between *two* (pure) substances.

* Berthelot has actually obtained a persulphate from sulphuric anhydride and a peroxide.

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The essential moment conditioning the occurrence of chemical change, according to the view of which I am an advocate, is the formation of a conducting system in which electrolysis can occur, and within which, as already said, change will necessarily take place so soon as the system is established, if exothermic change be possible under the conditions—as in the case of any voltaic cell. Substitutions on this hypothesis are but secondary results consequent on additions.

Much has been done of late to discover that water plays an all-important part in determining many chemical changes, but the nature of the influence which it exerts has been little considered, and I am alone, I believe, in pointing out that mere moisture should be insufficient to condition change in many cases—in the formation of water, for example, from hydrogen and oxygen, the interaction of nitric oxide and oxygen, or the action of chlorine on metals, etc., as in such cases there would not be an electrolyte present. On the other hand, it would presumably suffice to determine the interaction of ammonia and hydrogen chloride, for example, as the latter and water together form an electrolyte. I believe this to be the criterion by which the efficiency of water *per se* may be judged of: in other words, that it will *per se* condition the occurrence of an interaction between two substances only if it be capable of forming a composite electrolyte with at least one of them; in all other cases something besides water must be present which will render the water conducting by forming with it a composite electrolyte. The number of such substances is, as already pointed out, comparatively limited.

In further illustration of this argument, the rusting of iron may be referred to, notwithstanding its importance and the amount of discussion it has given rise to, the exact nature of the change is by no means determined. According to Crum Brown (*Journal*, Iron and Steel Institute, 1888, 2, 129), liquid water, oxygen, and carbon dioxide are the essential elements concerned in the formation of rust. But it may well be doubted if a solution of carbon dioxide in pure water be an electrolyte, in which case perhaps the carbon dioxide initially but serves to promote the formation of acid from a trace of some salt which happens to be present, and the primary product derived from the iron is the corresponding iron salt; this last, however, being even more amenable to attack by carbon dioxide than the salt originally present, the acid is continually regenerated. On this view it is easy to understand the protection afforded by an alkali. I have on more than one occasion urged that probably it is always necessary that liquid water systems should be formed if change is to occur, at least in the case of changes taking place under ordinary conditions—*i.e.*, at ordinary temperatures. Apparently it is only at high temperatures or under the influence of an electric discharge that this condition need not be secured, and in such cases it may be supposed that the conditions are such as to favour the momentary formation of what are practically liquid systems in the atmosphere within which the change occurs. It is not improbable that the influence which surfaces often exercise in promoting gaseous changes may at least in some part be due to the increased opportunity they afford for the formation of liquid systems to take place.

The absolute function which the (composite) electrolyte fulfils in such systems is obscure at present, as it is but stating a fact to say that the presence of a conductor is essential in order that a current may flow; it would seem not improbable that it in some way constitutes a mechanism whereby the discharge or degradation of the energy expended in the change is effected. The question is one of great interest and importance, especially when viewed in connection with the enquiry into the nature of valency and with the fact that an action impossible within an endothermic system at once takes place when an element (a depolariser) is introduced which constitutes the system one within which as a whole endothermic change can occur.

H. B. Dixon's observations on the combustion of carbonic oxide, as well as those of Victor Meyer and his co-workers on the formation of water, and also those of Pringsheim, followed by those of Victor Meyer and Bodenstein, on the formation of hydrogen chloride, all bring into prominence the fact that the occurrence of change in gases is dependent on conditions which are essentially of the same order as those obtaining in the case of liquids. Prof. J. J. Thomson's observations on the discharge of electricity through gases (*Phil. Mag.*, 1893, 36, 313) apparently prove that what is true of chemical change is equally true of the electrical discharges which can be produced in rarefied gases—that the phenomena in both cases, in fact, are electrolytic manifestations, and that discharge could not take place in a pure gas. It appears to me unnecessary to assume that such changes are dependent on the occurrence of atomic dissociation of the molecules of the interacting substances prior to the formation of the molecules of the substances which are the ultimate products; indeed, the observations referred to may almost be regarded as proof that such is not the case. No more striking evidence that the occurrence of a discharge in a gas is dependent on the presence of a something besides the gas—on the formation of a complex conducting system—could be given than is afforded by the beautiful experiment exhibited by Dewar at the Royal Institution, showing that the discharge at once ceases in one of Crookes's phosphorescent tubes on cooling with liquid oxygen. Such treatment cannot be supposed to cause the condensation of the residual air, but may well condition the deposition of the traces of vapour (? of conducting water) present in the gas, thereby destroying the systems within which conduction can alone occur.

It may be here pointed out that this argument is perhaps also at least partially applicable in explanation of the erratic behaviour of the discharge in vacuum tubes. If the discharge occur within a complex system, it may well be that certain conditions will favour the formation of a conducting system including one, and others of a system including another, of several substances present in a tube—such an explanation, for example, would account for the fact that the mercury spectrum is only sometimes seen in tubes connected with a mercury-pump. And having regard to the fact that a gas may exhibit several spectra, it may be that the spectrum of a given substance varies more or less according as it is included in one or other of several conducting systems.

If the occurrence of chemical change be dependent on the formation of liquid or quasi-liquid systems, the reduction of temperature sufficiently to produce solidification should prevent change. This is probably the explanation of observations such as have been made by Dewar and Pictet. There is probably no more effective method of drying, if drying be defined as the removal of liquid water, than that afforded by cooling to the very low temperatures obtained with the aid of liquid oxygen. In like manner, I am inclined to doubt whether any photographic action be possible at very low temperatures and would attribute the slight effect observed by Dewar to the action of the phosphorescent light emitted by the plate itself on the sensitive film after the temperature has risen sufficiently for the water within the film again to become liquid. I have long been convinced that photographic phenomena and procedure can and should be treated from the electrolytic point of view (*Camera Club Journal*, 1892, 61, 124; 1893, 48, 71).

We are but beginning to recognise that what is true of ordinary interchanges—*i.e.*, that the change takes place within a complex conducting system—must be equally true of changes of the converse order, so-called decompositions, including dissociation phenomena generally. Among the chief experimental contributions to our knowledge of this subject, we may reckon first and foremost the classical work of Grove on the decomposition of water at high temperatures, and the observations of Deville, as well as those of Victor Meyer and Langer, showing that the decomposition of carbon dioxide takes place in porcelain at a temperature several hundred degrees below that at which it occurs in platinum vessels. Perhaps Frederick Siemens, more than anyone, has dwelt on the influence of conditions other than those of mere temperature on the stability of substances at high temperatures.

It must always appear paradoxical that water should undergo decomposition at a temperature which necessarily must be below that which can be developed in its formation by combustion from hydrogen and oxygen; or, assuming that the effect is primarily of an electrical character, that it should be decomposed by an E.M.F. lower than that which can be developed by the interaction of the elements into which it is resolved.

The problem is akin to that involved in the electrolysis of water, which can be effected by E.M.F.'s much smaller than about 1·4 volts, the value calculated from the known heat of formation of water.

Two explanations are possible—one involving the assumption of dissociation, the other of an available external source of energy; it is needless to say that the former has long been the popular view. Reference has already been made to current views on the dissociation of water, and the question raised whether we are justified in concluding that water under ordinary conditions is dissociated, even to a very slight extent. But, whatever the ultimate conclusion, even if pure water be undissociated and an absolute dielectric, it may well be that in the case of a conducting mixture we are dealing with systems which, although free from any elements of dissociation, may yet be prone to undergo internal changes much after the manner of those pictured by Williamson in his celebrated essay on etherification (*J. Chem. Soc.*, 1851, 4, 110), changes which, as Fitzgerald has pointed out, would in effect be of the same order as those postulated by the modern school of dissociationists. On the other hand, it is not impossible that our conclusions are all based on observations made either with polarised electrodes or with media which have been to some extent impure.

In the experiment devised by Helmholtz and described in his Faraday lecture, the attempt was made, by means of an additional electrode of palladium which could be charged with hydrogen, to remove all traces of dissolved oxygen, and this object is supposed to have been effected; but I venture to doubt the possibility of securing complete depolarisation in such a manner.

With regard to its behaviour at high temperatures, if pure water be to some slight extent dissociated, even under ordinary

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conditions, as is suggested, it may fairly be expected that it would undergo further dissociation, to a greater extent and more readily than appears to be the case, as the temperature is raised; the important experiments made by V. Meyer and Langer on the behaviour of various gases at very high temperatures apparently also lend no support to this view.

(To be continued.)

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

April 28, 8 p m.—At the Institution, Great George street, Westminster. Ordinary meeting.

Institution of Electrical Engineers.

April 24, 8 p m.—At the library of the Institution, 28, Victoria-street Students' meeting. "Underground Conductors," by E. Ray and V. Watlington (students).

April 30, 8 p.m.—At the Institution of Civil Engineers, 25, Great George-street, Westminster. Paper on "Railway Telegraphs, with Special Reference to Recent Improvements," by W. Langdon (member).

Physical Society.

April 24—At Burlington House. "Symbolism in Thermodynamics," by R. A. Lehfeldt. "Adjustment of the Kelvin Bridge," by R. Appleyard. "The Effect of Wave Form on the Alternate-Current Arc," by J. Frith.

Society of Arts.

April 27, 8 p.m.—At John street, Adelphi. Cantor lecture. "Applied Electro-Chemistry." By James Swinburne. (The first of four lectures.)

April 29, 8 p.m.—"Fruit Drying or Evaporation." By Edward W. Badger.

Royal Institution of Great Britain.

April 30, 3 p.m. Third lecture by Prof. Dewar on "Recent Chemical Progress."

May 1, 5 p.m.—Annual Meeting; 9 p m, "Chronographs and their Applications to Gun Ballistics," by Colonel H. Watkin.

Institution of Mechanical Engineers.

April 20, 7.30.—At the Institution of Civil Engineers, Great George-street, Westminster. Continuation of the discussion on "Notes on Steam Superheating." By W. H. Patchell.

May 1, 7.30—At the Institution of Civil Engineers Paper on "Steel Steam Pipes and Fittings, and Benardos Arc Welding in connection therewith." By S. MacCarthy. "Research Committee on the Value of Steam-Jackets: Experiments on Locomotive Engine." By Prof. T. H. Beare and Bryan Donkin.

London Chamber of Commerce.

April 24, 12 noon.—At Botolph House, Eastcheap, E C. Meeting to consider the Government's Locomotives on Highways Bill, and Mr. Thornton's Vehicles (Lights) Bill.

North-East Coast Institution of Engineers and Shipbuilders.

April 25, 6 p m.—At the Athenæum, West Hartlepool. Election of officers. Resumed discussion on "Some Structural Details of Modern Ships," by M. C. James, and discussion on "The Determination of the Forces which Produce Vibration with Three-Crank Engines at High Speeds," by R M. Ferrier, and "Balancing High-Speed Engines," by A. E. Doxford.

Institution of Engineers and Shipbuilders in Scotland.

April 28, 8 p.m.—At Bath-street, Glasgow. Meeting. Election of officers, etc.

GAS v. ELECTRICITY AS AN INVESTMENT FOR TOWNS.*

The fifteenth general meeting of the Eastern Counties Gas Managers' Association was held on the 15th inst. at East Dereham, when Mr. Troughton read the following paper:

It recently occurred to me, after I had received several disappointing letters from our members declining to read a paper or get up a discussion, that I might give you a few figures relating to the growth of the Newmarket Gas Company, and its relation to the town as an investment, with the view of raising a discussion. Briefly, I may say that we are threatened with the electric light—first, by a private company who gave notice to the Board of Trade last October of their intention to apply for a provisional order; and, secondly, by the local authority, who have decided to oppose the company, because in years gone by the authority missed acquiring the gasworks and waterworks, which have turned out such good investments. Consequently, they made up their minds to apply for a provisional order, so as not to miss any more good things; and they will do so, I presume, next autumn. This opposition has, of course, stopped the company.

In passing, I may say that our town surveyor estimates that an electric installation costing £10,000 can be put down in Newmarket and worked at a profit of £600 a year. That 6 per cent. will be very nice when they have made it; but we hear of so many electric concerns that earn nothing at all, and so few that earn 6 per cent., that we may be excused for being somewhat dubious. I know several large towns which are supplying electricity at a loss.

The point I want to bring before you is that a gas company in a small or medium-sized town, with a growing business, is a better investment to the consumers of gas, who are the ratepayers, than is an installation of electric light, whether it be supplied by a company or by the local authority. We make and sell four times the quantity of gas that we did 20 years ago; and we are selling it at 2s. per 1,000 cubic feet less than we were then. I will give you a short statement of the growth: In 1875-6 we made 11½ millions, and sold it at 5s. 10d. per 1,000ft.; in 1879-80 we made 17¾ millions, and sold it at 5s. per 1,000ft.; in 1883-4 we made 22¾ millions, and sold it at 4s. 6d. per 1,000ft.; in 1889-90 we made 36½ millions, and sold it at 4s. 2d. per 1,000ft.; in 1894-5 we made 46½ millions, and sold it at 3s. 10d. per 1,000ft. This reduction in price is entirely due to the expansion of the company's business. The difference between 5s. 10d. and 3s. 10d. means that on our last year's sale of gas over £4,200 per annum was given back to the consumer by way of a reduced gas bill, and this sum will go on increasing with the company's business. Besides this, we have paid dividends for several years of 10, 11, and 12 per cent., and the last dividend was at the rate of 12½ per cent. upon all our capital.

Last year we obtained a special Act of Parliament, with the sliding scale and auction clauses inserted, which provides that all new capital shall be sold by auction or tender, and we expect to raise the £15,000 of new capital authorised at about 4 per cent., and the £15,000 of loan capital authorised at 3¼ per cent. We are at present offering £5,000 of debenture stock at 3¼ per cent., and this money will be expended on extensions as the demand arises. You will thus notice that we have power to raise £30,000, which we expect to get at from 3½ to 3¾ per cent., instead of alloting it among existing shareholders at par as formerly, and paying the usual 10 or 11 per cent. dividend upon it. There is a great saving here, and it affects the consumers of gas very considerably. If this capital is properly laid out on extensions, it should (and I think it will) earn 12 or 13 per cent. After paying the interest on it 9 per cent. will remain, which on the whole of the new capital will amount to £2,700. That will be apportioned under the sliding scale as follows: 73 per cent., or £1,964, of this sum will go annually into the gas consumers' pockets instead of into those of the shareholders as formerly, and only the remaining 27 per cent., or £736, will go to the original proprietors. I think this gives the consumers of gas a large interest in future extensions and developments of the gas company, which to a very great extent is carried on for their benefit, so far as future business is concerned; and the consumers are the general public, for, with the aid of the slot meter, we shall soon have everyone using gas.

I think a town that had quadrupled its make of gas in 20 years, and reduced the price 2s., may reasonably be expected to double again in 15 years, and at our present rate of growth we estimate that we shall do so. Assuming that we do, and are selling in round numbers 100 million cubic feet (which I do not think is an extravagant estimate), we ought, owing to the growth of the business, the benefit we shall have from cheaper capital, and the economies in production that follow growth, to be selling gas at 2s. 6d. per 1,000 cubic feet. This on a sale of 100 million cubic feet would mean the enormous sum of £6,666 being returned annually to the consumers of gas in the shape of reduced bills. That is, of course, looking ahead some 15 years; but I will come nearer home. That large sum of money will be given back to the consumers by degrees; they will not have to wait 15 years. Supposing we are enabled next year to reduce our selling price by 4d. on a sale of 46 millions, the consumers would get £800 in reduced gas bills. So you see the public have the prospect of getting almost immediately a further reduction of £800 per annum, or more than our surveyor estimates he can earn from the electric light.

But supposing the electric light comes in and prevents us extending our business as we are doing at present, it may have the effect of keeping the price of gas at its present figure; and instead of the gas company giving to the town a reduction equal to £800 per annum, the town itself will be the cause of the loss. But it might go beyond simply keeping the price of gas at its present figure. It might have the effect of causing it to be increased; for a company selling gas under the sliding scale may increase their price. Substantial reductions can be made in the price of gas only where there is a growing and

* From the *Journal of Gas Lighting*.

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increasing business. I do not, however, wish you to infer that there should be no electric light in our towns, because I think there is plenty of room for both illuminants in many. But in our small towns—in the Eastern Counties, for instance—I think figures such as those I have given should be laid before the public before they are "rushed" into a heavy expenditure to supply the electric light. We can all work out these facts as they apply to our own towns; and they should be forced home to the consumers and ratepayers when they are tempted with a glowing electric lighting scheme, for it can generally be proved that they have already a far better source of income in the gasworks than can be offered by electricity. Besides, the electric light may not pay even in the hands of the local authority, but, on the contrary, money be lost, which would have to be made up out of the rates; and the poor ratepayer would have to pay his quota to maintain a light which at present can only be termed a luxury for the well-to-do. Thus the many may have to help to keep the electric light going for the few. I know several of our members have questions relating to this subject before them at the present time, and if they will discuss them and give us their experience I shall be glad that I brought the matter before you to-day.

In conclusion, I think that with such a large interest in the local gasworks as the public undoubtedly have in nearly every town they should be slow to embark on a new enterprise which, as we all know, so seldom pays its way, and which, on the other hand, may prevent the gas company from conferring such large benefits on the town as I hope I have shown can be, and generally are, conferred by a growing gas concern, whether it be in the hands of a corporation or a company.

Discussion.

Mr. J. Dixon (North Walsham) remarked that in the town which he represented they were threatened with the electric light. The question had been discussed by the District Council, but in that body they had not one practical member who understood anything about the subject. It was curious to notice how, as soon as this question of electric lighting came before local authorities, the members at once seemed to know all about it One member on their Council who was a crockery dealer stood up and said that, in his opinion the electric light was cheaper than gas, but he gave no statistics in support of his statement. Another member - a draper—dilated upon the beauties of the light, and, indeed, from all that was said, it seemed that at North Walsham they were going to have electricity for nothing. Being a member of the District Council, and the secretary and manager of the gas company, he made certain enquiries, and, on mentioning the matter to a friend, he told him of Cowpen, where the electric light had been adopted and had proved a failure. He (Mr. Dixon) wrote to the chairman of the Blyth and Cowpen Gas Company for some information on the subject; and he replied in this way: "I must first explain to you that our town is composed of two townships—namely, Blyth and Cowpen—each having a separate district council. The Blyth Council have never used anything but gas in their district. The Cowpen Council and gas company could not come to terms. Hence the adoption of electricity, which was used for six years, and has now been abandoned, the Council having agreed to burn gas on the same terms as Blyth. The reason why electricity has been given up was brought about on account of the great expense of Cowpen lighting in comparison with Blyth, and also because while the back streets of Blyth had lamps, the back streets of Cowpen were in darkness. The public dissatisfaction showed itself by the election of new members on the Council who went in for gas. If you want information from what would be considered a neutral party, you might apply to the clerk to the Cowpen Urban Council." Acting upon this suggestion, he addressed the clerk of the District Council, who answered as follows: "The lighting area within the district of the Council was, for a period of six or seven years prior to May 15 last, lighted by electricity, but it was an utter failure. The system of lighting was by overhead wires the lamps being fixed in such a position in the main thoroughfares as was thought would light up the various back streets in the district. This it did not do, and during the whole time the electric lighting was in existence one-half of the district was not lighted at all. The Council have now returned to gas, and for a small district like this the system of lighting by gas is much cheaper. Prior to returning to gas the Council invited tenders for the lighting of the district by electricity, and they found that it would cost from £6,000 to £8,000 to lay down a proper installation. This was found to be so expensive that they eventually decided to return to gas. Taking the whole matter into consideration, I have no hesitation in stating that for a small town gas is the cheaper mode of public lighting." The publication of these letters in the papers circulating in North Walsham gave, said Mr. Dixon, much annoyance to the advocates of electric lighting. When he became secretary of the gas company, some 10 or 12 years ago, the price of gas was 5s. 5d., and it had been reduced to 4s. 2d. The system the company had followed had been to reduce the price as soon as they possibly could after raising the dividend, and they had met the consumers (of whom they had now 150) in every way. For the public lighting they received £140 from the town, including lighting, extinguishing, and cleaning. The argument for the electric light was that if it was taken up this £140 would pay for everything. Now, in small towns like North Walsham there was not room for two lighting companies—the one would spoil the other; and people seemed to overlook the fact that if the consumption of gas increased the gas company could, without any additional labour, supply at a cheaper rate. The price of 4s. 2d. at North Walsham, he thought, would compare with other places of an equal size. He did not know what the charge was at Dereham.

The **President**: We have two prices—3s. for cooking and 4s. 6d. for lighting.

Mr. Dixon proceeded to refer to other information he had collected during his investigations, and stated that he could not (with the exception of Thetford) find any place like North Walsham that was supplied with electricity at a cheaper rate than gas.

Mr. E. G. Smithard (King's Lynn), speaking of the "high" dividends electric lighting companies were supposed to be going to make said he saw in the *Journal of Gas Lighting* that the Belfast Corporation had made a profit of £385 during the past year, not allowing anything for interest or sinking fund, and that the gasworks had provided all that was necessary in that respect. As most of the members were aware, he was formerly at Chelmsford, where they had a little electric lighting. As Mr Troughton had put it, there was not room in a small town like that (where the gas company's make was between 30 and 40 millions) for both electricity and gas. At Chelmsford it affected their consumption something like 8 millions. They made at one time a maximum of 40 million cubic feet, and now it was 32 millions, the consequence being that the dividends were also affected. They would find it was so in all little places where they were running the two lights together—they would both be affected. He did not think there were any electric lighting works outside London that were paying dividends. As to the comparative prices of gas and electricity, of course everything turned on the cost of the electricity. In the paper read by Mr. Tew at the Belfast meeting of the Gas Institute in 1893 he stated that electricity could not be manufactured for less than 5d. per unit. This figure, light for light, would compare with gas at 4s. 2d per 1,000 cubic feet—taking a unit as being equal to 100 cubic feet.

Mr. Dixon remarked that he enquired of the Incandescent Gaslight Company as to how to calculate the difference between the cost of gas and electricity, and they put it this way: take the price of 4s. 2d. at which they were selling gas at North Walsham, the supply of five cubic feet per hour for 1 000 hours would come to £1, whereas electricity, at 6d per unit, would work out (roughly speaking) to 30s.

Mr. Smithard added, as to the cost of public lighting at Chelmsford, that the gas company's tender (which was not accepted) was, he believed, for £650, while last year something like £1,000 was paid for lighting by electricity. He was not prepared to say that there was not more lighting, but there was not sufficient to account for the difference. He understood that the tender accepted for electric lighting was for about £850.

Mr J. Barton (Peterborough) asked to be allowed to make a few remarks as to street incandescent gas lighting. At the last meeting, he said, they had a little discussion on that subject, and since then he had been making some experiments with the light in clusters of three. As he stated at the previous meeting, up to that time the lights he had tried had been a failure. He had, however, altered the lamps; and he was pleased to state that he had obtained much better results - he thought he might say they were pretty well perfect. The illumination from the incandescent lamps in the streets was certainly quite as brilliant as the incandescent lighting in the shop windows. This had been accomplished in this way: he had altered the 60-c.p. lamps by taking out the glass (or solid) bottom and substituting a perforated zinc plate, and this seemed to get over the difficulty. The incandescent light in clusters of three (a single one was the same) required a greater supply of air than an ordinary gas flame. The 60-c.p. lamp consumed say, 15 cubic feet of gas in the ordinary way, while the 180-c.p. incandescent gas lamp consumed practically 12 cubic feet of gas; but this 12 cubic feet required more air than the 15ft. As to the cost of electricity compared with gas he found that an electric lamp giving 10 c.p., compared with gas at 3s. 4d. per 1,000 cubic feet, cost ½d. per hour; but an incandescent gas lamp costing the same gave them 80 candles, or eight times as much light. That was the difference between the cost of electricity as given by electricians and the cost of incandescent street-lighting.

Mr. R. J. Sharman (Wisbech) said that at the last meeting he rather ridiculed incandescent gas lamps for street-lighting, but since then he had been induced to try the light again. He had had a lamp introduced to his notice that was particularly adapted for the incandescent light; and he had tried one, as the cluster light had proved a failure in the old lamp. He placed it in one of the worst possible positions he could find, where it would catch the wind from all quarters. It was put up in November; but after a fortnight, some misfortune occurred to the mantle, and it went to pieces. A new mantle was fixed, and from the end of November to the previous Sunday night the lamp had never, to his knowledge, been out or touched. It was blown out on Sunday night, and he himself went to relight it. It struck him that the lamp was not particularly dirty, though, of course, a cleaning would improve it. He believed the Corporation were now advocating incandescent gas lighting, and the company were prepared to fix the lights for them if they desired it. But the great point was whether they could adapt the present lamps or would go in for a special lamp. The lamp he had tried had certainly so far proved a success. As to the electric light, he did not think they, as gas managers, ought particularly to set up their backs against it, seeing that the introduction of the electric light gave them an impetus to improve gas lighting in order to compete with it. He thought there would be room for both systems of lighting. If towns liked to spend their money in electric

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lighting, let them do so; they would gain experience by paying for it. There was no doubt, when electric lighting was introduced, it woke gas companies up, and put them on their mettle, and had led to a considerable reduction in the price of gas The first duty of a gas manager was undoubtedly to the shareholders; but, at the same time, he ought to study the consumer, and produce gas at the least possible cost.

Mr. R. G. Shadbelt (Grantham) drew attention to the fact that the discussion had departed from the topic introduced by Mr. Troughton, which was something to this effect: Is electric lighting an equally good investment to gas? So far as he could see, he did not think it was. But gas managers were interested parties, and people did not take much notice of what they had to say on this subject. The only time at which they could object at all was when the local authority proposed to spend an amount of money as they would think wastefully, and then they could protest as large ratepayers. With this exception, he thought the best thing for them to do was to give electricity a fair field and no favour, and to meet it with truthful statements. He, as a gas engineer, could not help complaining of the untruthful statements electricians disseminated—it might be from over-enthusiasm, or indiscretion, or it might be that they did not understand the subject thoroughly. He thought the attention of electricians and that of the public ought to be drawn to this He knew of cases where the public were actually gulled, simply because they did not understand the subject. As to the adaptability of incandescent gas lights for street purposes, he might say that they had been experimenting with them at Grantham during the past winter. They had been guilty of not altogether adhering to the Welsbach lights, and they had tried a variety of kinds—whether rightly or wrongly remained to be seen. They put up about 30 burners, in groups of four, three, one double, and the remainder single, and in each case they took the lamp heads as they found them. His experience differed somewhat from that of Mr. Barton. Instead of increasing the air supply they had to reduce it Some of the bottoms of the lamp-heads were completely open, and the tops too. They found it advisable to check the air inlet at the bottom to prevent any flickering or sudden gusts of wind entering the lamp. The greatest importance, however, attached to the top of the lamp-head, as they found the down draught did more damage than the up draught. They checked this by putting in a little cone of perforated copper, or by surrounding the ordinary ventilator by copper or other equivalent according to the shape or size of the lamp. Out of the whole of the 30 burners they had not had a single failure. They had been able to adapt the whole of the lamp-heads, and the experiment had been an unqualified success.

Mr C. Ellis, referring to the electric lighting undertaking at Yarmouth, said the gas company had found it a rival; but, still, they had been making headway against it—last year something considerably more than the year previous. As far as the street-lighting was concerned, he did not know whether or not the Corporation had had sufficient of it; but since they had started the electric works the gas company had come to terms with them to light by incandescent lamps for three years the principal streets not illuminated by means of electricity. The arrangement was based on the consumption of ordinary street lamps—five cubic feet per hour; and they had something like 120 of the incandescent lamps in use These had been running for about 12 months, and he did not think the Corporation would be in a hurry to extend their arc lighting. The incandescent lamps were working very well indeed. They found it necessary to check the upward current of air, and by means of an ordinary leather collar over the copper tube they prevented the wholesale destruction of the mantles, which now averaged per lamp about four per annum.

Mr. Troughton, in the course of his reply, said he was pleased to hear Mr. Dixon give such an interesting account of Cowpen, as he happened to know that this place had been held up by parties advocating electric lighting as an example of prosperity. With regard to cheaper gas, that was one of the facts he wanted to press home in the short paper he had read. He thought it was of great importance to show the consumers and the ratepayers generally that by sticking to gas they would be helping to bring down the price. They could not go about preaching continually. But, as one speaker had mentioned, gas companies were large ratepayers, and when they were threatened with the electric light by the local authorities then was the time to educate the ratepayers. The reports made by the electricians were too glowing—at any rate, when looked at from the gas manager's point of view, and the public required enlightening as to the advantages that were to be derived from gas in order that they might make a fair, unbiassed comparison between the two systems. With reference to the statement made by Mr. Dixon as to Thetford, the electric lighting plant there, he believed, was originally put down for lighting the works of Messrs. Burl; and the installation was found to be of sufficient capacity for a few outside customers. It was not therefore fair to take Thetford as a town that was lighted by electricity.

Mr C Snelling (Thetford) intervened with the remark that one of the largest customers had returned to gas and was now using the incandescent light. He also mentioned that the gas company had lost the lighting of the Great Eastern Railway Station, and that the price of gas was 5s. per 1,000 cubic feet for lighting and 4s. 6d. for cooking purposes.

Mr. Troughton (resuming) referred to Mr. Smithard's remarks as to the electric lighting of Chelmsford. He pointed out that the light was supplied by a large local firm of electrical engineers (Messrs. Crompton), and said if they could supply it cheaply anywhere they would do so at home for an advertisement. Still, as Mr Smithard had shown, the townspeople were foolish enough to pay considerably more for the light than they would have to do for gas.

Mr Ellis: Recently the accounts of the Yarmouth Corporation electricity department showed a balance of £790 on the wrong side.

Mr. Smithard, replying to an enquiry as to the financial results of electric lighting at Chelmsford, said there was an admitted loss, but its extent was not publicly known.

Mr. Troughton (continuing) pointed to the results of the working of the Worcester electricity department as already recorded in the *Journal*, and also alluded to the fact that there were dividend-paying electric lighting companies, but they all occupied specially favoured districts, with numerous consumers on a short line of cable. But if a company started in a small town such as East Dereham, where the residents were far apart, it would cost a considerable sum of money to lay down the cables, and there would be a large proportion of leakage. He believed the leakage at Worcester last year was 25 per cent of the electricity generated. He was glad Mr. Barton had given them a few useful figures relating to the incandescent light, because that at the present time was a strong competitor of the electric light. Mr. Sharman had expressed the opinion that there was room for both gas and the electric light. Seeing, however, that, if there was a loss on the latter, the ratepayers had to "pay the piper," his (Mr. Troughton's) view was that, if they could prevent the light coming into the small towns they represented in the Eastern Counties, they would be doing the ratepayers a great kindness.

INSTITUTION OF ELECTRICAL ENGINEERS, April 16.

SIR HENRY MANCE in the chair.

In the discussion on Mr. Dane Sinclair's paper on "The Working of a Telephone Exchange,"

Mr. Addenbrooke followed Mr. Preece, remarking that his experience in connection with the Telephone Company covered the period of 1883 to 1886, when the company were getting things into shape, and when many of the problems that were now being discussed first began to make their appearance. Mr. Addenbrooke then went on to compare the time necessary to send a message and get a reply by post, by telegraph, and by telephone, with the view of enforcing the conclusion that an extremely rapid service was a much less important matter than thoroughly good speaking. Owing to the kindness of Mr. Preece, he had had the opportunity of trying both the Dublin and Paris lines, and he found that the speaking over them was better than over the majority of the company's lines not more than two miles long. There had been a great improvement in this respect in London from the double wire, but it was in the country, not in London, that the telephone had its greatest value, and there the difficulties did not meet them with which they had to battle in London, though perhaps they might be approaching them in such places as Manchester and Liverpool. There was thus a population of 30 millions which could be served with apparatus which had been all worked out. In a manufacturing district, for instance the works might be two miles distant from the nearest town, yet the population was dense, and the trunks would be only a few miles long. Under such conditions, with a good service, it ought to be almost like speaking to the next room. If that could be assured, it would not be necessary to be always able to get through in half a minute. If a subscriber could get through in five minutes it was all that was wanted, provided that the speaking was perfect and he could always get the answer he wanted.

Mr. Hawes did not see how certain troubles could be got over with a flat board. The system had now to work constantly, and when any repairs where required they had to be done while the switchboard was at work. Then as to the size of the board. For 6,000 subscribers it would be more than a yard square, and it would be impossible for the operator to reach across while sitting, and it certainly did not expedite the service for the operator to keep jumping up and down. Then, again, in pulling out one cord there was a danger of pulling out another with it. As to up and down trunk wires, when there were a certain number of junction wires between exchanges it was really better to use one-half for messages one way and one-half for the other way. It might not be quite so economical, but the work was done much quicker. He could not agree with Mr. Addenbrooke on the subject of the time taken to get through. Even in London he would be extremely annoyed if he had to wait five minutes for every call—and, of course, he had not to do so. Perfect working might be the result of a small number of subscribers, and an absence of junction wires made the service very rapid. As to what had been said about Berlin and the advisability of making the subscriber do as much as possible of the work, it was certain that in such a case the service seemed more rapid than it was, for when a man had something to do he did not notice that the time was going; on the other hand, the disadvantage was that if the connection was not made, the subscriber might go on ringing for ever and nothing would happen.

Mr. Somerville said with an upright board the operator was expected to stretch 3ft. 3in. on each side without interrupting her neighbours. She might be able to do it with plenty of elbow room, but with four operators the space allowed her was only 19½in. With a flat board it was much worse. To make some connections it was necessary to insert a jack at a distance of 4ft. Now, with eight operators at work this was impossible, and as a matter of fact the operator asked and received assistance for

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25 per cent. of the connections. Moreover, in the system described by Mr. Sinclair the subscriber's conversation was liable to be overhead by the operator and the subscriber annoyed by the question, "Have you finished?" It was pleasing to hear Mr. Sinclair advocate the use of flat boards and the call-wire system, although results seemed to indicate that his advocacy, until quite recently, must have been of a very mild type. Doubtless, however, he would by-and-by advocate their use even in London, his present objection being without foundation, as there was no reason for the King's Cross operator desiring to communicate with Lime-street doing either of the things he thought inevitable—viz, cutting herself off from the call wire, or joining her call wire with its 50 subscribers to the call wire to the City.

Mr. Dane Sinclair said that the speeches had occupied so long that he would hardly have time to reply to all the points raised. Mr. Kingsbury had condemned the call-wire system. If he had taken his experience of it from the Law system, that would not be surprising. It had been necessary to clear it out and replace it with the Mann system. With the Law system every subscriber had the power of breaking into the circuit and cutting off all who were beyond him. That and the make and break in the switch was too much for the system But when it was altered to the other way so that 20 might tap on, but the last could not cut the others off but had to wait his turn, the state of things was different. The question of the distance that could be reached was gone into experimentally, and it was found that the difference between the upright and the flat board in that respect was so small that there was absolutely nothing in it. Any board had its own difficulties, and the question was only one of choice between them. Increasing the number of jacks while operating was going on was not necessary. A few hours' work in the evening would be enough to put the jacks into place, and it was a more simple matter to lift out a row on the flat than on the upright board. The point referred to by Mr. Preece as to doing work among the wires underneath the flat board, the alleged difficulty came to this: that it would have to be part of the training of an engineer to behave himself when in close proximity to one of the opposite sex. They had carried it out in practice, and he (Mr. Sinclair) had not heard of any detrimental results. He considered that great credit was due to Mr. Preece in that he had been an early and earnest champion of the metallic circuit. There was, however, the commercial side of the question to be considered. The company were at that moment metallic circuiting Manchester, because the Corporation there had invited them to go underground. In describing what was done at Berlin, Mr. Preece had quoted the very reason why he (Mr. Sinclair) liked the call-wire system. It threw the responsibility of the working into the hands of the subscriber, but with the difference that if the subscriber at the other end did not answer, the caller was told so With the battery system of the Post Office the mechanical working was no doubt perfect; but when the signal was given at the exchange what happened after that was at the command of the operator. With the call wire the caller had got her and she was bound to give him some reply, while with any ringing system he would have to wait until she chose to be ready. In the one case the subscriber commanded the situation; in the other he did not.

The usual vote of thanks was passed to the reader of the paper, and the **Chairman**, in closing the proceedings, remarked that the most satisfactory point brought out was the rapid increase of the double-wire circuit. That involved a matter of great interest to electrical engineers who might have to do in any way with electrical tramways, and he hoped that Mr. Gavey in his paper next session would be able to tell them what was expected and to give them some rule in that respect by which an electric contractor could work.

The next meeting is on April 30, when Mr. Langdon's paper on railway telegraphs will be taken.

LEGAL INTELLIGENCE.

THE ST. PANCRAS EXPLOSIONS.

In the Queen's Bench Division, on the 17th inst., the case of Houldsworth *v.* the Vestry of St. Pancras came on before Mr. Justice Cave and a common jury.

The plaintiff's claim was for injuries caused in February, 1895, by an explosion in a culvert under Gee street, in possession and under the control of the defendants, and in which a quantity of coal-gas had been allowed to accumulate It was plaintiff's case that a spark from the defendants' mains ignited the coal-gas, and there was an explosion, in consequence of which the plaintiff suffered shock to the system and acute inflammation of the optic nerve of the right eye. The defendants denied that the explosion was caused in the way alleged and that the injuries the plaintiff suffered were caused by the explosion. The defendants also alleged that the culvert was constructed with reasonable care and as required by law.

Mr. Witt, Q.C., and Mr. John Raymond appeared for the plaintiff; and Mr. Lawson Walton, Q.C., and Mr. Albert Gray for the defendants.

The **Plaintiff** was called, and gave evidence that as she was walking along she heard an explosion, felt a numbness in her feet, and was very frightened. A fortnight afterwards she had bad pains in her head, and her right eye became bad.

Dr. Ernest Clarke, ophthalmic surgeon, gave evidence as to the condition of the plaintiff's eye on March 12. In cross-examination he said neuritis, from which plaintiff was suffering, was common in both eyes, but more uncommon in one. In one eye the more obvious cause was a blow.

Mr. Tasker, an electrician, gave it as his opinion that the ventilation was imperfect, as there was no outlet for the gas. He also considered the insulator was imperfect, being only 1in. in vertical length instead of 4in. or 5in The bearers were faulty, being of wood. Wood was always liable to absorb moisture, and an alkaline incrustration would then be liable to be formed. In cross examination the witness said the system used in St. Pancras Vestry had been approved by the Board of Trade.

For the defence **Mr. Marcus Gunn**, ophthalmic surgeon, said in his opinion the fact that the neuritis was only in one eye tended to show it was not caused by the explosion.

Mr. Lawson Walton, Q.C., for the defendants, contended that the inflammation of the optic nerve was not the result of the explosion. Further, that as the Vestry had been empowered to lay down wires charged with electricity, if they carried out the work with reasonable care, they were not liable. Modes of ventilation which were thought admirable some time ago were not now thought to be good Wood bearers were net, at the time these were put down, thought to be insufficient. No negligence on the defendants' part had been shown.

Mr. Witt, Q.C., contended that the defendants were liable as creating a nuisance on the highway. He cited Shelfer *v.* City of London Electric Lighting Company (1895, 1 Ch, 287).

The jury found for the plaintiff, damages £105 and judgment was given accordingly, but a stay of execution was granted.

CLAIM FOR ELECTRICAL APPLIANCES.

At the Westminster County Court on Monday, before his Honour Judge Lumley Smith, Q.C., the case Swinbourne *v.* Andrews was tried.

The plaintiffs, a firm of electrical engineers, sought to recover payment of an account in respect of a dynamo and a number of arc lamps supplied to the defendants, Messrs. Andrews and Co., who are also electrical engineers. The plantiffs' case was that the arc lamps, which were made to order, were of a very peculiar character and involved a good deal of extra expenditure in their manufacture. They were made to defendants' own drawings, and it was not until payment was pressed for that any complaint was made either as to their price or the working.

The defence was that both the dynamo and the lamps were very faulty in construction, and that the prices charged were much in excess of those agreed upon.

His **Honour**, having heard the evidence of several witnesses, expressed the opinion that it was a case which might very well have been settled between the parties, but inasmuch as it had come before him he must decide it. He should cut the plaintiffs' claim down to £45, for which amount they would have judgment with costs.

COMPANIES' MEETINGS AND REPORTS.

NORWICH ELECTRICITY COMPANY.

The annual meeting of this Company was held last week at Norwich, Mr. F. W. Harmer presiding.

The directors' report stated that the success realised during the first 15 months of the Company's working had been fully maintained during the past year. The demand for current, both for lighting and motive power, had continued to increase in a most satisfactory manner, the number of customers being now considerably in excess of that of 1894. A large number of private houses had been wired, and the directors thought that at length the public were beginning to appreciate the enormous advantages of electricity as compared with any other method of lighting. During the year upwards of two miles of new mains had been laid, making the total length about seven miles. The revenue account for the year showed a credit balance of £2,847. 3s. 1d., to which must be added £112 5s. 8d., brought forward from last year, making a total of £2,959. 8s. 9d. From this was to be deducted £749. 3s 5d. for interest on debentures, etc., leaving a balance of £2,210. 5s. 4d. With this the directors propose to declare a dividend of 3½ per cent., free of income tax, amounting to £991. 12s 10d., to place £1,100 to depreciation account, and to carry forward the balance to next year.

The **Chairman**, in moving the adoption of the report, said if the shareholders compared this year's report with that issued 12 months ago they would find it to be most satisfactory. The income had increased £2,000—that was to say, from £3,786 in 1894 to £5,845 in 1895, and this at a much smaller expense, for while coal cost £994 in the former year it was only £1,300 in the latter, and in salaries the increase had been in the same proportion. Of course, the expense to which they were put was not for coal, but for interest on capital. That increased fast, and he was afraid it was likely to do so. But there was this to be said, that the directors had not only learned how to make electricity, but how to do so at a profit, which was still more important.

Mr. H. S. Patteson seconded, and the report and accounts were then adopted.

The retiring directors and auditors having been re-elected, the **Chairman**, in reply to a vote of thanks, said that it had been to him a labour of love to do all he could for the Company, for it was congenial to his tastes, and he was glad the thing had been successful.

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ORIENTAL TELEPHONE AND ELECTRIC COMPANY.

The second ordinary general meeting of the Company was held on Wednesday at the Cannon-street Hotel, Mr. Wm. Addison in the chair.

The **Chairman,** in moving the adoption of the report and statement of accounts, which were taken as read, and which were published in our issue of last week, congratulated the shareholders on the satisfactory progress of the Company, and especially on the realisation of what had been for years the hope of the directors in being able to recommend out of the net profits of the year a dividend at the rate of 5 per cent. With reference to the loss of their exchange in Colombo, the directors had been in continuous negotiation throughout the year with the Government of Ceylon, which had already given them notice that it would not renew their license about to expire at the end of December, 1895. With all due respect to the Government, he thought they had been treated in this matter in a way that was very discouraging to private enterprise and unfair to a company which had invested a considerable sum in the colony, and was ready to invest still more freely if it could have obtained continued security from the Government. Nor had the directors received that measure of support from the Colonial Office which, under the circumstances, they felt they were entitled to ask. In the end, the Board had to accept a sum which represented only a small part of the value of the exchange, upon which they had spent in cash £4,856 odd, to which must be added goodwill and compensation for forcible dispossession. The suspense account in the balance-sheet in regard to the Colombo exchange amounted to £2 481 odd. This sum could easily be liquidated by the profit on their consols if they were to be sold, together with the amount now proposed to be carried forward, after paying the dividends recommended. As, however, the matter had only been finally closed in the current year, they had thought it best to carry the amount to a suspense account, leaving its ultimate adjustment for future consideration.

The motion was seconded and adopted.

Mr. B. St. John Ackers and Mr. G. B. Frost were re elected directors. The auditors were also re-elected, and the meeting terminated with the usual votes of thanks.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY, LIMITED.

The report of this Company for the half-year ending December 31 states that the gross receipts, including Government subsidies, amounted to £311,582, against £261,322 for the corresponding period of 1894. This large increase is mainly due to the exceptionally heavy traffic transmitted to and from Western Australia in connection with the gold-mining industry that has recently sprung up in that colony. The working and other expenses, including £20,713 for cost of repairs to cables and expenses of ships, absorbed £84,044, against £89,740, leaving a balance of £227,538. From this is deducted £4 318 for income tax, £20,000 transferred to the fire insurance fund, £31,895 for interest on debentures, debenture stock, and contribution to sinking fund, leaving as the net profit £171,325, which, with £70,504 brought forward, shows an available balance of £241,829. One quarterly interim dividend of 1¼ per cent. has been paid, and it is now proposed to distribute another of like amount, making, with the interim dividends paid for the June six months, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent.; making a total distribution of 7 per cent. for the whole of 1895. The balance of £129,329 has been carried to the general reserve fund, which now stands at £561,546. The system has been strengthened by the renewal of 340 knots of the New Zealand (original) cable and 109 knots of the Tasmanian (original) cable. The cost of these renewals, amounting to £38,733, has been debited to the general reserve fund, together with £186,044, the balance of cost of the alternative Singapore-Hongkong cable. Further extensive renewal work will have to be carried out during the current year. In accordance with the provisions of the trust deed, dated May 10, 1879, 409 of the 5 per cent. Australian Government subsidy debentures, amounting to £40,900, were drawn by lot on April 1 for payment at par on July 1 next. With a view to placing the tariffs on a more uniform and satisfactory basis, the directors have decided to reduce the local rates as and from July 1 next. The immediate effect will certainly be a considerable falling off of revenue, but it is hoped that the lower rates will lead to such an increase of business as may eventually recoup the initial loss.

The general meeting of the Company takes place on April 29 at two o'clock at Winchester House, E.C.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL COMPANY, LIMITED.

The report of this Company states that the accounts are sub mitted in conjunction with those of the "Metall" Company, and show that an important reduction has been made in the capital—the whole of the £25,980 second debenture stock has been redeemed, and 10,337 ordinary shares have been handed by the holders for cancellation as a donation to the Company in order to improve its position. The benefit to both preference and ordinary shareholders by this reduction is apparent, as it has enabled the directors to write off the deficit standing to the debit of the Company, and to reduce the value of amount standing to patent account by £1,441. The amount due to this Company from the "Metall" Company is now £19,008. The two mortgages which are held as security are now in the hands of Lord Farrer of Abinger and Mr. J. R. Holland, as trustees for the debenture holders. The directors have agreed to waive one-half of their fees for the past year. With regard to the "Metall" Company's accounts, it will be seen that the capital has been reduced to 600,000 marks (or £30,000) in order that the loss standing to the debit of profit and loss should be written off: also that £2,512 has been spent in new plant. This includes, amongst other things, two new draw benches, which were started at the beginning of this year. With regard to the trading account, the sales are more than double those of 1894, and a comparison with the trading account for that year will show that notwithstanding this and the fact that the stock-in-hand has increased by £2,200, the manufacturing purchases (excluding copper), wages, etc., have increased only in a very small proportion. The transfer of a loss in 1894 of £9 to a profit of £3,654 is satisfactory. The directors regret that a loss of £1,575 is shown upon the year's working, but they desire to point out that this has been brought about by the large sum of £2,554 written off as depreciation on the various assets. An arrangement has, however, been made whereby in the future only such sum as actually represents fair wear and tear shall be written off. With regard to the work generally the experience gained at the factory shows that to produce the highest quality copper, it was advisable to work at a lower rate of deposit than was at first adopted; therefore the plant erected does not produce the amount that was anticipated, and it is of importance that the number of tanks be increased. This can be done at a comparatively small cost, and it is proposed to put down 16 additional large tanks at an early date. It is necessary to issue a further amount of debenture stock to pay for the new plant, the additional copper required, and to pay off the overdraft at the German bankers, which is guaranteed by two of the directors and two shareholders. The directors consider that the business warrants the expenditure, and they are assured by the works manager that more than sufficient orders will be offered to keep the new plant at full work.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Oberjesingen (Wurtemburg).—Tenders are invited by April 27 for a church lightning conductor. Particulars from the Konigl. Evangel, Pfarramt.

Ixworth (Suffolk).—Tenders for lighting Ixworth streets must be addressed to Mr. S. M. Randall, clerk to Parish Council, Ixworth, and reach him by May 15.

Prague (Austria).—Tenders are wanted by June 1 for an electric lighting central station for the city of Prague. Application should be made to the Stadrath, Prague.

Bruges.—Tenders are wanted by May 13 for the supply and erection of an electric water-level indicator for the River Lys. Particulars from Le Gouvernement Provincial, Bruges, Belgium.

Stralsund (Germany).—Tenders are invited for installing the electric light on a steamer. Particulars for 1·50 marks (1s. 6d.) from the Werftbureau, Konigl. Wasser-Bauinspection, Stralsund.

Chapelle-lez-Herlaimont.—Tenders are wanted by May 15 for erecting three lightning conductors on the Hôtel Communal. Address, M. le Bourgmestre, Chappelle-lez-Herlaimont, Belgium.

Sunderland.—Tenders are invited by April 29 for an evaporative tubular surface condenser. Particulars can be obtained from the borough electrical engineer, at the supply station, Dunning-street, Sunderland, on deposit of one guinea.

London, E.C.—The Great Indian Peninsular Railway Company are prepared to receive tenders for the supply, among other stores, of sulphate of copper and miscellaneous wire by April 30. Particulars may be obtained at the company's offices, 48, Copthall-avenue.

Hampstead (London).—The Vestry of St. John's want tenders for a 300-kilowatt steam alternator, feed-water heater, tank, switchboard, etc. Particulars can be obtained from the vestry clerk, at the Vestry Hall, Hampstead, and tenders must be ready by April 27.

Leipzig.—Prices are wanted by May 2 for about eight tons of sal-ammoniac, four tons of sulphate of copper, about seven tons of zinc, and a quantity of copper wire and telegraphic apparatus and stores for exportation during 1896. Application should be made as speedily as possible to Hachmeister und Thal, Leipzig, Georgenstrasse 5.

Lisbon.—Tenders are wanted by the Royal Portuguese Railway Company for the supply of articles and material necessary for the upkeep of their electric lighting. Tenders must be sent to the chief engineer, at the company's stores at Santa Apolonia Station, Lisbon, by May 6, and particulars can be obtained there, or at the company's Paris offices, Rue de Châteaudun 28.

Eston.—The Eston Urban District Council invite schemes for lighting the district by electricity. Such schemes to embrace (*a*) plan and estimated cost, (*b*) annual working cost and maintenance. Plan of the district may be seen and particulars obtained of Mr. T. W. Stainthorpe, A.M.I.C.E., district surveyor, Grange town, Yorkshire, to whom the plans, etc., must be sent by May 1.

Lima (Peru).—Tenders for the electric lighting of the city of Lima will be received up to June 1 next at the Peruvian Legation, 13, Comeragh-road, West Kensington, W., where applicants can obtain a memorandum explaining the local conditions. The

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tenders will be opened and considered by the Municipality of Lima, which reserves to itself the right of selecting that which is most approved or rejecting all if it thinks fit.

Hull.—Tenders are required for the supply of coal from May 1 to December 31, 1896, for the Electric Light Committee in accordance with the conditions set forth in the forms of tender, which may be obtained at the electric light station, Dagger-lane. The contractor will have to enter into the usual form of contract required by the Corporation. Tenders, endorsed "Steam Hards for Electric Light Station," should be sent under seal to the Chairman of the Electric Light Committee, Town Hall, Hull, by noon on 30th inst.

Oldham.—The Technical Education Committee of the Oldham Corporation are prepared to receive tenders for the wiring of the Technical School, Ascroft-street. The installation will consist of 34 arc lamps. Specifications and plans can be obtained from Mr. S. Wilmott Newington, borough electrical engineer, Gas-street, Oldham, on payment of £1. 1s., which will be refunded on return of the specification, accompanied by a bona fide tender. Tenders, endorsed "Tender for Wiring," must be sent to the office of Mr. A Nicholson, town clerk, Town Hall, Oldham on or before noon, May 1, 1896.

St. Helier (Jersey).—Persons wishing to establish a lighting station in the locality for the purpose of supplying electric, gas, or other forms of light, for both public and private use, are requested to communicate with Mr. P. Baudains, constable, Town Hall, St. Helier, Jersey. All such preliminary communications are to state (1) form of light—*i.e.*, whether electric, gas, etc.; (2) in the case of electric light, what methods of generation and distribution would be adopted; (3) proportionate price for public purposes and private lighting; (4) general conditions under which tenders would be made. All necessary information will be supplied on application.

Antrim.—The Commissioners for the Control of Lunatic Asylums will receive sealed tenders up to 10 a m. on May 1 for the supply and erection of an electrical installation at County Antrim Lunatic Asylum. The tender should be sent in a sealed envelope, endorsed outside "Tender for Electric Lighting, County Antrim Asylum," and addressed to the secretary, Board of Control, Custom House, Dublin, and should be accompanied by a separate sealed envelope, similarly addressed and endorsed, containing the detailed estimate. Forms of tenders, and copy of specification, which has been prepared by Mr. J. H. Greenhill, M I E E., will be issued on application to the office of the Board of Control of Lunatic Asylums, Dublin, on deposit of £3, which will be returned to all persons who have sent in bona fide tenders. Plans can be seen at the office of the architect, Mr. John Lanyon, Northern Bank-chambers, Royal-avenue, Belfast.

Coventry.—The Electric Lighting Committee require tenders for the supply and erection of the following plant: (Section A) boiler-house plant—boilers and fittings, mechanical stokers and economiser, feed pump, etc.; (Section B) engine-house plant—steam-engine, alternator, oil filter, fittings, etc., steam, exhaust, feed blow-off, sundry pipes, valves, etc. Tenderers are at liberty to tender for either section, but not for part of a section. The ground plan of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation Ormond House, Great Trinity-lane, London, E.C., on and after 24th inst. on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. Lewis Beard, town clerk, St. Mary's Hall, Coventry, and delivered by May 12.

London, S.E.—Tenders are required for supplying and fixing complete electric light machinery required for the public baths and wash-houses now in the course of erection in Manor-place, Walworth-road, for the Commissioners for Public Baths and Wash-houses for St. Mary, Newington. Any person desiring to tender may, after depositing £5. 5s. with the architect, Mr. E. B. I'Anson, 7A, Laurence Pountney-hill, Cannon-street, E C. (to be returned on receiving a bona fide tender), obtain a copy of the quantities and inspect the drawings and specification at his office between 11 a.m. and 2 p.m. A tender will only be accepted on condition the contractor signs a declaration that he will pay to the workmen employed by him not less than the recognised trade union rate of wages in each branch of the trade. Tenders to be endorsed on the envelope "Tender for Engineers' Work to the Public Baths and Wash-houses, Manor-place, Walworth-road, S.E.," and to be delivered at the office of Mr. L. J. Dunham, clerk, Vestry Hall, Walworth-road, S.E. by 3 p.m. on 29th inst.

Shooter's Hill (London).—Tenders are wanted by May 6 for the provision and fixing of electric bells, telephones, fire alarms, etc., at the Brook Fever Hospital, Shooter's Hill, S.E., for the Metropolitan Asylums Board. Copies of the specification form of tender, conditions of contract, and of the drawing, which have been prepared by Prof. Kennedy, LL.D., F.R.S., of 14, Old Queen-street Westminster, S.W., can be obtained at the chief offices of the Board on and after 16th inst. upon depositing gold or Bank of England note to the value of £5 (which will be returned only to those who send in a bona fide tender in accordance with the terms of this advertisement, and who return the drawing, specification, and conditions of contract). Tenders, which will only be received on the lithographed form supplied by the Board, must be sealed and endorsed "Tender for Electric Bells, Telephones, etc., Brook Hospital," and must be delivered at the Chief Offices, Norfolk House, Norfolk-street, W.C., by 2 p.m. on May 6. Unless the tender be accompanied by the specification, conditions of contract, and the drawing it will not be considered.

RESULTS OF TENDERS.

Harrogate.—The tender for the construction of a steel roof for the electric lighting shed by Messrs. J. Abbott and Co., of Gateshead, for £623. 4s. 9d., has been accepted by the Town Council.

Sunderland.—The contract for fuel economiser in connection with the extensions at the Corporation electric light station has been placed with E Green and Son, Limited, of Manchester and Wakefield.

Birmingham.—The contract for the wiring and fitting of the new general hospital has been placed with the Birmingham Electric Supply Company, Limited, and the supply of electricity required for the lighting, and also for power purposes, will be from the company's supply mains.

Brussels.—The successful tender for electric light buildings and other work at the Luttre station, on April 15, was that of M. V. Ernaelsteen, Waterloo, at 11,044fr. The lowest tender for work in connection with the water supply and electric lighting at the Marbehan station was that of Messrs. T. Hustin, Ethe, at 34,814fr.

Bradford.—The tenders have been received for the new electricity station works at the junction of Valley-road and Lionel-street, for the Corporation. The accepted tenders were: building—J. Moulson and Sons, Bower-street, excavators and masons; H. Thirkill, Nelson-street, carpenter and joiner; Hill and Nelson, Edmund-street, slaters; Roberts and Co., Limited, Union Foundry, Cutler Heights, ironfounders; R. Townend, Croft-street, plumber and glazier; T. Bolton, Tudor-street, plasterer and concretor; G. J. Walton, Great Horton-road, painter; Wood Block Flooring Company, 11, Queen Victoria-street, London, E.C., wood block flooring; A Broxup and Sons, Great Horton, reservoir and tank; Coalbrookdale Company, Limited, Coalbrookdale, Shropshire, gates and railings. Electrical plant: Epstein Electric Accumulator Company, Limited, Victoria-mansions, 28, Victoria-street, London, S.W., battery; Cole, Marchent, and Morley, Prospect Foundry, surface-condensing plant; British Insulated Wire Company, Limited, Prescot, Lancs., cables; J. Booth and Bros., Rodley near Leeds, travelling crane; J. Spencer, Globe Tube Works, Wednesbury, Staffs, steam and exhaust pipes. Rest of Bradford.

BUSINESS NOTES.

West Ham.—Mr. G. H. Risch has been appointed borough electrical engineer.

Coventry.—The new premises built for the London and Midland Bank are lighted by electric light.

Perth—A handsome electric organ has been erected in Kinnoull Parish Church at a cost of £1,000.

Folkestone.—At the meeting of the Town Council the town clerk reported as to the position of the electric light order.

Crieff.—Arrangements are being made to have the telephone extended to the town in connection with the National Telephone Company.

Budapest.—The accounts of the Budapest Electric Tramway Company show a profit allowing of a dividend at the rate of 10 per cent.

Dudley.—The Streets and Gas Committee are going into the question of the gas supply thoroughly, and will fully consider the possibilities of electric lighting.

West India and Panama Telegraph Company.—For the two weeks ended April 15 the receipts were £2,802, as against £2,307 for the corresponding period of 1895.

Dublin.—The Rathmines, Blackrock, and Dundrum Tramways Company have received sanction from the Township Commissioners to construct two miles of electric tramway. The cost is estimated at about £55,000.

Chelmsford.—Messrs. Crompton and Co. have come to terms with the trustees of the Johns estate. Several acres of land near the Writtle-road Cemetery have been secured for the site of the firm's new electrical works.

Reading.—At the annual Vestry meeting of the parish of St. Lawrance, the question of lighting the church by electricity was discussed, and referred for consideration to a meeting of the Church Board, which will be summoned shortly.

The London Tramways Scheme—The promoters of the project for amalgamating the London tramlines and working them by electric traction have got as far as circularising the members of the London County Council on the subject.

German-American Cable.—A correspondent of the *Financial Times* has called attention to the fact that the German Government have granted a concession for a German cable to the United States, and to its possible effect on the English companies' receipts.

Eastern Telegraph Company, Limited.—The Company announce the payment by warrants on May 1 of interest for the half-year ending April 30 on the 4 per cent. mortgage debenture stock. The transfer books will be closed from 27th inst. to May 1, both days inclusive.

Portsmouth—At the last meeting of the Town Council, a recommendation by the Electric Light Committee to extend the low-tension electric light mains from Elm-grove through Yarborough-road and The Retreat to Grove-road, at an estimated cost of £100, was agreed to.

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Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending April 19 amounted to £1,151, as compared with £1,386 in the corresponding week of the previous year, being a decrease of £235.

Grimsby.—The estimate for public lighting by gas for the next six months amounts to £1 800, which the Town Council consider a very heavy item, and they wish they could see their way to make it less At the last meeting the chairman told them their only chance was in electric lighting.

Eastern and South African Telegraph Company, Limited.—The Company announce the payment by warrants on May 1 of interest on their 4 per cent. Mauritius subsidy debentures for six months to 30th inst. The transfer books will be closed from 27th inst. to May 1, both days inclusive.

Tooting (Surrey).—The Wandsworth and Clapham Guardians are going to reconstruct St. Joseph's College, and the original scheme provided for an item of £367 for electric lighting, but the committee have now left this out, among several other items, because they found that the work would cost more than was at first supposed.

City and South London Railway.—The returns for the week ended April 19 were £921, compared with £856 for the corresponding period of last year, being an increase of £65. The total receipts for the half-year terminating as above were £15 260, compared with £15,218 in the same period of the preceding year, being an increase of £42.

Spain —Plans have been presented to the local authorities of Vich by Ricart and Ca. for a lighting and power plant of 300 h.p. Conditions for the electric lighting of Belchite (Tarragona) are to be published shortly. It is also probable, says the Barcelona *Revista Tecnologico-Industrial*, that electric lighting works will be shortly established in Orviedo

Stockton.—At a meeting of the Cleveland Institute of Engineers, Mr. Dawson, C E , Westminster, read a paper on "Electric Tramways." He related his experiences of the tramways throughout the Continent and in the States, and also those in Coventry, Dublin, and Bristol. The overhead system in the last-named city he especially commended as a model one, and, repudiating the allegations of ugliness brought against the overhead system, spoke of its great economy.

Yarmouth.—The monthly report of the Electric Lighting Committee presented at the last meeting of the Town Council stated that applications had been received from 10 customers for 606 additional lamps, making 160 customers for 7,603 lamps. The income for March was £180. 16s. 8d., and the expenditure £142 8s 11d. The General Electric Company's tender for carbons for the ensuing 12 months was accepted, it being the lowest sent in with satisfactory samples.

Continental Metropolitan Tramways Company, Limited.—The report of the Company for 1895, to be submitted at the ninth ordinary general meeting held in London to-day (Friday), states that the question of the substitution of mechanical for horse traction has now reached an important stage, the authorities having asked the various companies for information as to terms other than that of the extension of the concession upon which they would agree to the general adoption of mechanical traction.

Leamington.—At a meeting of the Town Council the Lighting, etc., Committee reported that they had considered the letter from the Midland Electric Light Company referred to them, and had had an interview with Mr. Jones, the manager. After discussing the details of the arc light system, they adjourned the further consideration of the question, and instructed the surveyor to obtain results from Oxford, Derby, and Wolverhampton, where the arc light is in use, and especially with reference to the Jandus system.

St. Mary Woolnoth Church.—An amicable arrangement has been come to between the promoters of the City and South London Railway Bill and the members who have been opposing it on behalf of the church of St. Mary Woolnoth. Mr. H. C. Richards will now refrain from moving the rejection of the measure, and the company have agreed to accept an instruction to the committee to consider what provision can reasonably be made for the preservation of the church without preventing the construction of the railway and station.

Worcester.—The Water and Sewage Committee have gone into the cost of steam and electric pumping at the waterworks and have passed the following resolution: "That although this committee are of opinion that the cost of pumping water at the waterworks by electricity is considerably more than if pumped by steam, yet as the electricity department is under the Council's control, this committee recommend the Council to pay for current supplied to the waterworks motors during the financial year of 1896-97 at the rate of 1½d. per unit."

Radcliffe —At the meeting of the Urban District Council, the Electric Lighting Committee reported that Messrs. Boardman and Cunliffe had interviewed the Earl of Wilton's agent with reference to the sale of the plot of land adjoining the sewage works, and that he ultimately agreed to recommend the trustees of the estate to accept the sum of £500 per acre for the plot if the Council would make that offer, but that he could not promise that it would be accepted. It was resolved that the trustees of the Earl of Wilton be offered the sum of £500 per acre for the plot of land adjoining the sewage works in Mount Sion-road.

Warminster.—At a meeting of the Urban District Council the Clerk said the notice putting an end to the contract with Mr. M. Hill for the lighting of the lamp on the fountain by electricity expired on March 25, and it was now for the Council to take the cable from off his premises. Mr. Chambers thought the Council might ask Mr. Hill if he would be prepared to supply the current to light the lamp at £15 a year as before. Mr. Daniell thought Mr. Hill should be allowed to light the lamp as often as he liked, as he had no claim on them for the light and he did not see there was any cause for complaint. The subject then dropped.

Huddersfield.—A Bill has been introduced into the House of Commons to confirm a provisional order granted by the Board of Trade to the Corporation applying the Huddersfield Electric Lighting Order, 1890, to the whole of the county and municipal borough, subject to the Corporation within one year after the commencement of the order laying down and thereafter maintaining suitable and sufficient distributing mains in that portion of Longwood-road situate between Paddock Head and Longwood Church. The Corporation is empowered to manufacture and supply for hire lamps, conductors, machinery, and other apparatus.

Kensington.—Notices and plans have been received from the House-to-House Electric Supply Company relative to extensions of their mains in Drayton gardens, Fulham-road, Sumner place, Selwood-place, Onslow-gardens, and Cranley-gardens, and the Vestry have given permission for the work being proceeded with subject to the conditions that the plans be approved by the Vestry's surveyor and lighting engineer, and that the works be carried out under their supervision and to their satisfaction; that the work be completed within three months of the date of sanction; and that the boxes be efficiently protected against accumulations of gas and water.

Swansea.—Mr. Richard Martin made some sensible remarks at the Corporation meeting in moving the adoption of the Electric Lighting Committee's minutes. These minutes stated that the committee had refused various offers for the provisional order. Mr. Martin said if they had parted with the order, outsiders would have got in for the sake of the plunder. He pointed out that in the case of gas the company had enjoyed a monopoly that had for years given them a considerable revenue. As soon as the electric light was talked about, the company offered to light some of the streets with incandescent gas for nothing, but they had not reduced the price of gas. At present their gas bill came to £5,273.

Dewsbury.—At the meeting of the Town Council the Lighting Committee reported that they had received a letter from the Board of Trade forwarding a copy of regulations for securing the safety of the public, and for ensuring a proper and sufficient supply of electrical energy Messrs. Jas. Smith and Sons, patent dry cleaners and dyers, Hartley street, have abolished the old method of driving their machines by steam, and are using electricity as the motive power. Already the results have been found to be far more satisfactory than those gained under the old steam system. The firm are about to lay down a larger motor and a 600-light dynamo, and when that is done they contemplate using electricity to heat the flatirons, etc., used in the laundry department.

New Gold Mining Companies and Electricity.—The Woodley's Reward Gold Mines, Limited, registered with a capital of £250,000, takes power to construct, maintain, and work rail and tram roads, electricity supply works, telegraphs, telephones, etc. Registered office, 19, St. Swithin's lane. E C. Hutton's (Bechuanaland) Gold Reefs Development Company, Limited, registered with a capital of £300,000, takes power to construct and maintain rail and tram roads, telegraphs, telephones, etc. Registered office, 69 Moorgate-street, E.C. The Great Victoria Gold Mining Company, Limited, registered by Mayo and Co., 10, Drapers'-gardens, E C., with a capital of £75,000, divided into 75,000 shares of £1 each, takes power to construct, maintain, and work rail and tram roads, telegraph and telephone systems, and electric works, etc.

Newport (Mon.).—Alderman Moses, in bringing up the report of the Electric Committee at the last meeting of the Town Council, referred to the charge of having a defective meter at the museum at the free library. It was the fact that as yet no perfect meter had been found for accurately measuring the amount of electric energy consumed. The meter at the museum had registered a consumption when there was no consumption, but he complained that the Museum Sub-Committee had, instead of working in harmony with the Corporation, gleefully gone on taking the register of their defective meter for weeks before consulting the electrical engineer or any of the officials. He could not find language to condemn such a practice. Some of the meters in the town registered against the interest of the Corporation.

Ayr.—The committee who have been considering the question of tramways have reported strongly in favour of a scheme. As regards the question of the motive power, the committee are unanimously in favour of electricity. They say that electric energy has been found to be specially suitable for tramways in places like Ayr, where the gradients are easy and the traffic medium. The Corporation electricity works will have little to do in the summer, and the tramway would take up the load during the day. The committee find they cannot report further on the proposed undertaking without ascertaining the particulars of similar schemes in actual work, but they intend to keep themselves posted with the latest literature on the subject, and, if the Council approve, to visit some of the most recent ventures in tramway undertakings.

Parliamentary.—In the House of Commons on Monday the Liverpool Electric Supply (Transfer) Bill (sent down from the Lords) was considered and ordered for third reading. The Belfast Street Tramways Bill, the Dublin Southern District Tramways

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Bill, and the Portsmouth Street Tramways Bill were read a second time. The motion for the second reading of the City and South London Railway Bill was postponed till to day (Friday). The Electric Lighting Provisional Orders (No. 1) Bill having complied with the Standing Orders of the House of Commons, has been sent for second reading. The Bill confirms certain orders made by the Board of Trade under the Electric Lighting Acts of 1882 and 1888 relating to King's Lynn and other places. On Tuesday the Brighton and Rottingdean Seashore Electric Tramroad Bill was read a second time.

Brighton —At the meeting of the Town Council the Lighting Committee reported that they had received a letter from Mr. J. L Neale forwarding a memorial requesting that the portion of Dyke-road between North-street and Goldsmid-road may be lighted by arc lamps. It was resolved that the memorialists be informed that the committee deem it inexpedient to light the portion of the Dyke road referred to with arc lamps, but that the incandescent lamps proposed to be fixed will be an increase of about 50 per cent. on the present gas-lighting. A letter was read from Councillor Stringer requesting that the gas lamp in London-road, at the corner of Baker-street, may be lighted. It was resolved that Mr. Stringer be informed that the matter to which his communication relates is receiving the consideration of the committee. At a further meeting of this committee it was resolved to erect an additional lamp in Baker-street. The proceedings were confirmed without discussion on the motion of Councillor Stafford.

Halifax.—Mr. Rienzi Walton has held a Local Government enquiry respecting an application by the Corporation for sanction to borrow £20,000 for the purposes of electric lighting. The Town Clerk (Mr. K. Walton) said the Corporation had previously obtained borrowing powers for £39,950 for the purposes of electric lighting, but up to the present £43,355 had been expended The Corporation were already supplying 12,000 eight candle lamps, and the demand was rapidly increasing. The existing installation had not yet paid its way, the loss last year, including interest, being £1,090. It had, however, been in existence only 15 months. Councillor Hebden opposed the application, because there was no provision in the loan for developing electricity as a motive power for running machinery The plant was practically lying idle during the day, but if it were then used the committee would be able to reduce the price to consumers He contended that £5,000 of the £20,000 should be used for the development of electricity as a motive power The inspector made a note of the objection.

Blackpool.—The staff and employés at the Corporation electricity works have presented Mr. John Hesketh, the borough electrical engineer, with a handsome case of cutlery, on which was inscribed the words: "Presented to Mr. John Hesketh by the staff and employés of the Corporation electricity works, Blackpool, on the occasion of his marriage with Miss Laurie Hinnell, April 14. 1896." The proceedings were most enthusiastic. Mr. Hesketh, in his reply, said that mention had been made of his early departure, and while another opportunity would be given them of entering into this matter again before he left Blackpool for Queens land, he would ask them to give his successor, whoever he might be, the same hearty co-operation in everything that they had given him, and he was sure his successor could not fail to be fully satisfied. The Corporation have lodged objections to the *locus standi* of the Blackpool, St. Annes, and Lytham Tramways Company and the Lancashire and General Tramways and Carriage Company, both of whom have presented petitions against the Blackpool Improvements Bill.

Dover.—At a Vestry meeting at Buckland, Dover, where the electric light has been installed in the church just over 12 months, the Vicar was very emphatic in his approval of it. He said it had only been in use about a year, but he would not hesitate to say that it was prolonging his life. One of the churchwardens, Mr. Lewis, mentioned that there had been a considerable saving by the use of the electric light in the place of gas At the meeting of the Town Council, the Mayor remarked that in the course of a few days there was every probability of the Council receiving the provisional order for the tramways. The inspector had been down and everything proposed met his approval. Then, perhaps, in the course of a week or two they might hear some of their friends on the virtues of horse, electricity, gas, or petroleum trams, and they would be able to decide which was best. He thought they would be glad to hear that the work had gone on so rapidly and met with none of the delays usual in dealing with Government offices. The Town Clerk remarked that, of course, the order would have to be confirmed by Parliament. The electric light will be laid on throughout the Lord Warden Hotel, and the mains are now being attached.

Southwark (S.E.).—Mr. Howard Smith, barrister, and Mr. J H. Hallett, consulting engineer. the commissioners appointed by the Board of Trade under the Boiler Explosion Acts, 1880 1892, held an investigation last week into the circumstances attending the explosion of a boiler at the Southwark Electric Lighting Station, Bankside. The Board of Trade was represented by Mr. K. E. K. Gough, and Mr. Forman appeared as counsel for the City of London Electric Lighting Company, the owners of the boiler. About 6 p.m. on February 25 last there was a rush of steam and hot water in the stokehold, whereby Peacock, a fireman, was badly scalded. He died on the following morning at Guy's Hospital. The commissioners found that the engineers had acted to the best of the knowledge which they then possessed and had honestly acted on the opinion which they had formed, that the period within which they had directed that the boiler should be cleaned was sufficient to allow an ample margin of safety, which opinion was confirmed by that of independent skilled witnesses. They found that neither the City of London Electric Lighting Company nor any of their employés were to blame for the explosion, and made no order as to costs.

Edinburgh.—At the meeting of the Town Council the treasurer (Mr. M'Crae) made a statement as to the draft provisional estimates of expenditure for the ensuing year. He said that in regard to the Cleaning and Lighting Committee there was an increase on the lighting estimate of £3,865, brought about by the large increase in the electric lighting of the streets. As to the Electric Light Committee, whereas last year they had an expenditure, after allowing for the income, of £1,260, it was estimated the surplus would be £7,490. It was remitted to the Electric Lighting Committee to consider and report upon the charges for electric energy to consumers for the year beginning May, 1896. The Lord Provost's Committee have been directed to consider as to the desirableness of constructing a circular tramway at or near the proposed extended boundary of the city, to be worked by electric or other motor, and connecting the routes at present sanctioned by the Magistrates and Council with the proposed circular route.

Tudor Accumulators.—We have received the price-list for 1896 of the Tudor Accumulator Company, from which it appears that considerable improvements have been made in the cells, as well as a great reduction in the price for batteries to be used for stationary purposes. It is interesting to see that all batteries supplied by this company are guaranteed for two years, and that the manufacturers are prepared to contract for the maintenance of stationary batteries at rates varying from 3½ to 6 per cent. of the list price. The new features are mainly to be found in the cells for traction purposes, in which an extremely high rate of charge has been adopted, and the makers claim that the full capacity can be obtained after 20 minutes' charging. This will allow of the cells being charged *in situ* on the car at the end of the journey. As a guide to the output claimed, it may be said that a cell weighing 80lb. has a capacity of 150 ampere-hours when discharging at 30 amperes, and 120 ampere hours at a discharge rate of 60 amperes. The same weight of cell will also give at extra high-current rates 75 ampere-hours with a discharge at 150 amperes, and would be always charged at this current. The decrease of capacity with an increased rate of discharge appear to us to be less than in some other types of accumulators.

Bedford.—At the quarterly meeting of the Standing Joint Committee the question as to the installation of the shire hall or part of it with the electric light, which was adjourned 12 months ago again came up for discussion. The report of the special committee, as laid before the Joint Committee a year ago, was read and was to the effect that the offices and approaches could be installed for about £80, and the rest of the building for £145. In answer to Mr. Wright, it was stated that the gas bill for the shire hall varied from £24 to £29 per annum. Mr. Pym said his own experience of the incandescent light was that it was difficult to deal with. The glasses often broke and it required constant attention. Before they adopted the incandescent light they ought to make enquiries as to whether it had been so successful as was stated. The electric light was very simple and once they went to the expense of the installation there was no more trouble with it, so it was worth considering. Mr. Pope thought they might try an experiment with an incandescent light to see how it answered. The Clerk said he had tried it in his office, but it was not to his satisfaction. It was an improvement on ordinary gas, but one objection was that even when the brackets were rigid the lamps frequently broke. The matter was referred to the special committee.

Electric Lighting of Trains.—The new system of lighting trains by electric light has been inaugurated on the Glasgow and Edinburgh line of the North British Railway Company. The system, which has already been largely adopted by Southern companies, is the invention of Mr. Arthur B. Gill London, who was present at the opening run, during which the light was exhibited with conspicuous success. The main principle of the system is to light each vehicle independently, and by means of separate accumulators provision is made for keeping each carriage lighted during stoppages. The current is supplied by dynamos which gradually acquire the necessary speed when the train starts, and the general regulation and continuous upkeep of the supply have been carefully provided for. It is claimed by the patentee that the expenditure is largely confined to the initial cost, and that a considerable saving can be effected as compared with gas, the complete supercession of which is considered only a matter of time. The Caledonian Railway Company, after long enquiry regarding the various methods of applying electricity for the lighting of railway carriages, have given orders for an experimental train to be fitted up. In the event of the trial proving satisfactory the system will be extended to the passenger carriages of the company generally.

Bristol.—The Telephone Company recently approached the Sanitary Committee with a scheme for placing the main wires underground throughout the city, and the borough engineer was requested to report on the matter, and to embody in his report particulars of charges imposed on telephone companies by local authorities in other towns. The engineer has reported in favour of the scheme, and says that the charges vary very considerably, from a moderately substantial sum to a merely nominal one. The recent additional outlay by the Town Council of £10,000 involved in extending the private supply mains has been fully justified. Before the extension only 17,420 lamps were supplied; the number now supplied is 28,210, and, in addition, applications have been received for current for 1,200 lamps. The large output of electricity has considerably reduced the cost of production per unit, and, consequently, the Electrical Committee have not recom-

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mended the provision, in the rate of April, 1896, of any sum beyond the cost of street-lighting, all expenses for the repayment of loans and interest, working expenses, and maintenance of the undertaking being paid out of revenue. The committee want to extend the system, and an estimate has been prepared by the electrical engineer showing that the cost of enlarging the central station, purchasing additional machinery, and extending the mains will amount to the sum of £75,000. By means of this outlay the number of lamps will be increased from 34,000 to 76,000.

Dundee.—The new operation theatre at the Royal Infirmary has been fitted with electric light and electric appliances. The electrical fittings for medical and surgical purposes have been supplied and fitted by Messrs. Mavor and Coulson, of Glasgow, and the current is supplied from the hospital accumulators. In addition to the ordinary galvanic and faradic fittings, a galvano-cautery and a small electromotor for driving a drill by electricity are provided. The whole of the theatre and other rooms have been fitted up with electric light by Lowdon Bros., of Dundee. The large central swing electric light runs on travelling bars, and can be moved to any required position by means of a small windlass A meeting of the Works Committee has been held with reference to a proposal to place the telephone system of Dundee on the twin electric return system, which will necessitate the main routes of wire being placed underground. After a good deal of discussion the principle suggested was generally approved. Mr. Gaine stated that the National Telephone Company would bear the whole cost, and allow the work to be carried out by the Police Commissioners themselves at the sight and to the satisfaction of their own surveyor. With regard to any other consideration to the Corporation, he reminded the meeting that that body already received from the company a consideration equivalent to about £120 per annum in the form of lower rates at which telephonic communication was given to the Lord Provost and several public officials of the city, but notwithstanding that he would recommend the company to give a certain amount from the subscribers whose wires went underground. An adjournment was made in order that the committee should further consider the whole matter and formulate their terms.

Appointments Vacant.—The Corporation of Blackpool invite applications for appointment to the position of resident working electrical engineer to the Corporation. Applicants will be required to undertake the management and control, under the instructions of the Electric Lighting Committee, of the present electricity works of the Corporation, and must be thoroughly competent to design and supervise the construction of all plant, machinery, appliances, and cables necessary for the public and private lighting of the borough, and any necessary extension of such plant, machinery, appliances, and cables, and should have a thorough experience as an electrical engineer to a corporation or company working under parliamentary powers. The gentleman appointed will be required to devote the whole of his time to the service of the Corporation, and will not be allowed to engage in private practice. Canvassing either directly or indirectly by or on behalf of any applicant will be deemed a disqualification Applications, stating salary required, and date when applicant will be at liberty, and accompanied by recent testimonials (not to exceed four in number), endorsed "Electrical Engineer," must be forwarded to Mr. T. Loftos, town clerk, Blackpool, by 27th inst.—The Gas Committee of the county borough of Salford require a switchboard attendant for their central station. Salary 35s. a week. Applicants must have had experience in central-station work on high-tension system. State age and experience, and send copies of three testimonials to the Chairman of the Gas and Electricity Committee, Gas Offices, Blocm-street, Salford, endorsed "Switchboard Attendant," before 5 p.m. on April 29, 1896. Canvassing will disqualify —An assistant is required in the physical department of the City and Guilds Central Technical College, Exhibition-road, S.W., having a practical knowledge of alternating-current working and of the designing of alternators. Salary £100 per annum. Apply in the first instance by letter to Prof. Ayrton.

Cork.—The report of Mr. E. W. Walsh, C.E, engineer to the promoters of the electric tramway scheme, which was read at the last meeting of the Public Works Committee, stated that the promoters contemplated an overhead system, carried on centre poles with brackets in the wide streets, and on side poles with brackets or span wires in the narrow streets; the poles and posts and their position to be subject to the approval of the city engineer, and they might be used as lamp-posts by the Corporation or any lighting company that the Corporation might authorise to use them. The voltage would not exceed 500, which is now the Board of Trade limit, and the whole of the electrical appliances would necessarily be subject to the Board of Trade regulations, which are of a most elaborate character to prevent damage to person or property. The usual height of trolley wires was 18ft. over the surface, which was ample, seeing that a railway bridge was required to be only 16ft. The fire-escapes, in the event of having to pass anywhere that there are span wires, could be run horizontally, as they are in American cities. The promoters would agree to be subject to any reasonable conditions in connection with the rights or interests of the Corporation with regard to the formation and maintenance of main and branch sewers, etc., water, gas, and other mains, by-laws and traffic regulations. They also agreed that the position and levels of the lines in the various streets and roads should have the approval of the city engineer. The report was adopted. At the meeting of the Harbour Board, it was decided that Mr. Ronan, law agent, and Mr. Price, engineer to the Board, should attend before the meeting of the Town Council to watch the interests of the Harbour Board when the application came before the Corporation from the electric tramway company. A special meeting of the Council has since been held to consider the application of the company for authority to construct and maintain tramways which will be worked on the overhead trolley system. After a thorough investigation, a resolution was unanimously passed approving the scheme.

Leeds.—At a meeting of the Highways Committee of the Leeds Corporation the minutes of the Tramways Committee were approved. They included the appointment of Dr. Hopkinson as engineer of the electrical tramway from Kirkstall to Roundhay, terms satisfactory to the committee having been arranged. Dr. Hopkinson will take the full responsibility of the equipment, and he has been instructed to prepare the necessary specifications. Mr. Hewson, the city engineer, has also been instructed to prepare plans for the power station near to Crown Point. It is said that overtures between the Highways Committee and the Sanitary Committee, with the object of securing for the former body early possession of the Crown Point depôt as an electric power station, have reached an advanced stage, and that as much progress as possible is being made with the work of equipping the new electric section and erecting apparatus for generating power as can be expected, considering the delicate character of some of the operations. The *Yorkshire Post* says that the extent to which the trial of electricity as a tramway motor resolved on by the Corporation will affect the telephonic system of the city is likely to be far more serious than most people imagine. It will be remembered that the "mixing-up of currents" between the telephone and the electric tramway wires on Roundhay-road was the subject of a lawsuit. Since then the Board of Trade has made important alterations in its regulations bearing upon the laying down of electric tramways. Apart from these new rules, the National Telephone Company, for the convenience of their subscribers, are said to be willing to transfer a large number of their wires that are now carried on poles to conduits underground. The outlay involved will, of course, be a very serious item Some authorities estimate the cost at from £30,000 to £40,000 On the other hand, the company would avoid the cost of "way-leaves" over buildings and other miscellaneous charges incident to overhead wires, and would prevent interruptions such as brought them and the Roundhay Park line lessees into the law courts. The proposals are before the Highways Committee.

Devonport.—The Devonport Electric Lighting Provisional Order Bill has complied with the Standing Orders of Parliament. The order gives the Mayor and Corporation authority to supply electricity throughout the borough. The Corporation shall not, without the consent of the Board of Trade, place any electric line above ground, except within premises in the sole occupation or control of the Corporation, and except so much of any service line as is necessarily so placed for the purpose of supply. Power is given to the Corporation to purchase or lease lands for the purposes of the order to the extent of five acres; to construct street boxes for the supply of energy. It is provided that within two years the Corporation shall lay down suitable and sufficient distributing mains in Fore-street, Tavistock-street, and Marlborough-street, and in addition shall at any time, after 18 months, lay down distributing mains throughout every other street upon being required to do so. All such mains are to be laid down within six months after any requisition served upon them has become binding upon them, or such further time as may in any case be approved by the Board of Trade. The Corporation shall, upon being required to do so by the owner or occupier of any premises situate within 50 yards from any distributing main, in which they are for the time being required to maintain, or are maintaining, energy for the purposes of general supply to private consumers give a supply for such purposes, and they shall furnish and lay any electric lines that may be necessary for the pupose. The cost of so much of any line as may be laid upon the property of such owner, or in possession of the occupier, and of so much as it may be necessary to lay for a greater distance than 60ft. from the distributing main shall, if the Corporation require, be defrayed by the owner or occupier. The maximum power with which any consumer shall be entitled to be supplied shall be of such amount as he may require not exceeding what may be reasonably anticipated as the maximum consumption on his premises. Whenever the Corporation make default in supplying energy, they shall be liable to a penalty not exceeding 40s. a day Prices charged by the Corporation to any ordinary consumer otherwise than by agreement may be based on the actual amount of energy supplied, or by the electrical quantity contained in the supply, or by such other method as may from time to time be approved by the Board of Trade. When the Corporation charge by the actual amount of energy supplied they shall be entitled to charge at the following rates per quarter: for any amount up to 20 units 13s 4d., and for each unit over 20 units 8d. Power is taken to transfer, if they see fit, the privileges of the order, with the consent of the Board of Trade, to any company or person.

Glasgow.—Councillor Crawford and Mr. Young, who made investigations on the Continent of Europe into the working of mechanical tramway motors for the Corporation, have issued their report They visited Brussels, Hanover, Berlin Dresden, Budapest, Vienna, Milan, Genoa, Paris, and Rouen, and their general conclusions are that the time has arrived when the Corporation should make arrangements for beginning as soon as convenient to work some of the tramways by mechanical traction. The overhead system of electric traction is the best they have seen, and can be made applicable to any part of the city. The Corporation should begin by testing this system on one important route, and as the increasing traffic is sure to require further extensions of the

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tramway service before next summer, a trial line should be got ready by next spring to save further extension of the present system. In the erection of overhead wires, the cross span wires, they recommended, should be fixed to buildings wherever possible. Hamburg is stated to have the largest installation of electric traction in Europe. At the meeting of the Corporation Mr Primrose, in moving the adoption of the minutes of the Watching and Lighting Committee, called special attention to the report submitted by the joint sub-committee on gas and electric lighting of the streets, which had already been published. The further outcome of this investigation would probably be put before the Council at a later stage. The committee were at present experimenting with a small circuit of the existing lamps, which they proposed to alter for the overhanging lamps. The success or non-success of that experiment would determine the treatment of the remainder of the pillar lights. As members had seen from the report of the deputation on the subject, there was a possibility of electric traction being introduced in connection with the tramways and that might probably lead to the solution of the question of the lighting of the leading thoroughfares by electricity. It was extremely likely that it might be found convenient and profitable to unite street-lighting with the development of traction by electricity. Mr. Primrose rose to propose the following resolution, of which he had given notice: "That it be remitted to the Watching and Lighting Committee to consider whether the present arrangement under which that committee pay the same rate per 1 000 cubic feet of gas consumed in street and stair lighting as the ordinary consumer is an equitable one for the community, and whether means could be devised for the improvement of the general lighting of the city, and report." On a point of order, the Lord Provost said that under the Act of Parliament the Corporation could not carry the motion into effect, even though it was agreed to, whereupon Mr. Primrose said he would readjust his notice of motion.

Lambeth.—At a special meeting of the Vestry, held yesterday week, the question of providing electric lighting for the parish came up. Mr. Stacey Gold introduced a deputation from the Ratepayers' Association asking the Vestry to hand over to a private company the provisional order which it obtained some time ago. After Mr. Gold had answered several questions, Mr. Boyd, on behalf of the Lambeth Municipal Electric Lighting Committee, introduced another deputation asking the Vestry to retain the provisional order in its own hands and to carry out the lighting of the parish itself. The Chairman said he had consulted the clerk, and he was of opinion that the resolution of the Vestry of September 5, 1895, must be rescinded before they could consider the report of the Electric Lighting Committee recommending that the provisional order should be handed over to Mr Sax. Mr. Williams moved, and Mr. Troy seconded, "That the decision arrived at by the Vestry on September 5, 1895, as to the Vestry's electric lighting order may be altered so as to allow the Vestry to adopt the recommendations made in the report of the Electric Lighting Committee dated March 25, 1896, with such modifications thereof as the Vestry, on the consideration of such report, may resolve to adopt, and that any previous resolutions as to the Vestry's electric lighting order contrary to such recommendations and modifications may be revoked." Mr. Alderman Hubbard opposed the motion, and stated that he had never heard any reasons from any of the members of the Electric Lighting Committee as to why the resolution should be rescinded. After discussion, the Vestry voted on the motion to rescind the resolution of September 5, 1895, which ran as follows: "That the clerk be directed to write to the County of London and Brush Provincial Electric Lighting Company and the Capital and Counties Electricity Supply Company, intimating that while not in possession of sufficient information to justify an immediate proceeding under the provisional order obtained, the Vestry have no intention of surrendering the order." This was rescinded by 54 votes to 32 Mr. Williams then moved that the report of the Electric Lighting Committee be adopted by the Vestry. (The report appeared in these columns last week.) Mr. Newton seconded. Mr Prichard moved to refer the report back to the committee. Mr. Everitt seconded the amendment, and after a heated discussion it was rejected by 50 votes to 32. Mr. Hewitt moved, "That the consideration of the matter be adjourned until after the Vestry elections." Mr. Orfner seconded. After further discussion, the Vestry adjourned at 11 p.m., without coming to a decision. We understand that an independent ratepayer has written the Vestry advising that an independent expert should be employed to see that good machinery is installed. It would be well for the Vestry to investigate the independence of the ratepayer, and also the independence of the suggested expert.

Belfast.—At a meeting of the Council in committee the Lord Mayor reported that the special committee appointed by the Council to meet the directors of the Belfast Street Tramways Company, Limited, in reference to the question of electric traction had on the previous day had a conference with those gentlemen, who had, however, placed proposals before the committee which were of such a nature that it was deemed desirable to summon the Council as a whole to consider the matter. The town clerk then read the offer of the tramways company, which contained the following: "The figures which the chairman mentioned to the Lord Mayor this morning as constituting the expenditure of £200,000 which would be entailed by the installation of electric traction, and which the Lord Mayor asked us to put in writing, are as follow: (1) doubling single line (to be authorised by Order in Council), £28,000; (2) doubling single line on Ligoniel and Sydenham lines, £8,250; (3) purchase of these lines, £20,000 (this would give a complete system of 23½ miles); (4) street work for electric traction, 23½ miles, at £2 200), £51,700; (5) power plant, 23½ miles, at £1,050, £24,675; (6) 100 electric motorcars at £500, £50,000; (7) add for widening the existing lines to 6ft, purchase of County Down Railway Tramways, and for contingencies, £17,375. If the term is extended to 21 years the company will be willing to sell the purchased tramways - (1) Sydenham, (2) Ligoniel, (3) County Down Railway—to the Corporation on the same terms as their own, and the company's opposition to the Boundary Bill will, of course, cease. Having regard to the large expenditure of £200,000, the company cannot see their way to the adoption of electric traction unless the term is extended, especially in view of the great doubts explained by the chairman as to how much of the expenditure would come back at the end of the present term in 1907. I think you may assume that if the company's proposal for the extension of the term by seven years is agreed to, the conditions set forth in the report of the deputation of the Corporation would be in the main accepted." After two hours' discussion, Councillor Young moved, and Councillor Curley seconded, "That the Council in committee approve of the recommendation of the special committee to permit the tramways company to get an amended Bill, as may be settled by the town clerk, for the protection of the interests of the city, and with the clause that none of the powers of the Bill are to be exercised without the consent of the Corporation being first obtained." Alderman Henderson moved as an amendment, "That the Belfast Corporation, now in committee, desire to inform the directors of the Belfast Street Tramways Company, Limited, that they decline to accept the offer made to them this day by letter, and also that they will not agree to any extension of the term already held by them." Councillor Harper seconded the amendment, which was carried by eleven votes to six.

Bradford.—At a meeting of the Gas and Electricity Supply Committee the town clerk (Mr. W. T. McGowen) referred to an application which is to be made to the Privy Council by the Westinghouse Electricity Company, Limited, for a renewal of certain patents for distributing the electric current by means of the three or five wire system. The authorities of Bradford, Hull, Glasgow, and Dundee, recently adopted the system, the patent rights for which have been acquired by the Westinghouse Company, who have given notice of their intention to apply for an extension of the expiring patents for a further term of 14 years. The Town Clerk reported that the joint objections of the interested bodies opposing the application had been formulated and duly lodged with the Privy Council, with whom the decision rests. The document contains 10 clauses of objection. In the first place, it is contended that the inventor has already received full and adequate remuneration, or, if he has failed to do so, he has himself to blame. It is also alleged that the invention is not the only method of distributing electricity by a three or five wire system; that the Westinghouse Company acquired the patent, not for the purpose of assisting the inventor, but merely as a trading speculation; and that, even if they have not received adequate remuneration, this is not sufficient ground for the extension sought Further clauses contend that the present holders of the rights have already had full and adequate remuneration for the invention, or, if they had not done so, their failure is due to negligence and refusal to grant licenses on reasonable terms. It is also asserted that if the petitioners had exacted royalties from all users in the same manner as they had exacted from the objectors, they would have realised a very much larger profit than they have made. The objectors state that they paid large sums of money by way of royalty on the understanding that the patent would expire next July, and they contend that the alleged invention is not of such special or exclusive merit or public utility as to be a sufficient justification for any extension of the patent. Mr. Rienzi Walton, one of the inspectors of the Local Government Board, has held an enquiry into the application of the Corporation to borrow £40,000 for the purpose of extending the electricity works The Town Clerk stated that the Corporation were the first public body to adopt electricity as an illuminant. They were compelled to take this step in 1888, in consequence of having received notice from several companies of their intention to apply for powers to enable them to commence operations in the borough. The Corporation felt it was in the public interest that they should have control over any such undertaking An initial expenditure of £20,000 was incurred, and their venture proved to be so satisfactory that in 1890 the works had to be extended at an additional cost of nearly £30,000. In 1893 a further sum of £30,000 was borrowed for extensions, making altogether a total of £80,000, the outlay of which was duly confirmed upon the occasion of each extension by the Local Government Board. Of this amount £74,162 had been actually expended; there were liabilities to the extent of £3,514 leaving a balance of £2,324 to work upon. The Corporation now found it necessary to borrow £40,000, which it was proposed to expend as follows: site, £2.609; buildings, £11,500; condensing reservoir and 200 yards of 12in. iron pipe, £220; machinery, £10,325 (including engines £4,400; dynamos, £2,650; boilers. £3,000; feed pump, £175; weighing machine, £100); steam-pipes, £1,135; condensing plant, £1,500; electric lighting of building, £50; batteries. £750; switchboard, £500; cable, £4,000; travelling crane, £320; and cables for changing mains from two-wire to three-wire system, £7,000. Evidence was given by Mr. A. H. Gibbings (the electrical engineer) in support of the application. He said that in January last the present electric lighting plant was 18 per cent. below the standard requisite to enable the Corporation to adequately deal with the demand, and at the present rate of increase in the requirements, the plant would be 30 per cent. below the demand during the pressure of next winter. No opposition was offered, and the enquiry then closed. Mr. Walton afterwards visited the site of the proposed extensions.

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PROVISIONAL PATENTS, 1896.

APRIL 13.

7760. Improvements in double-pole switches for electric lighting. Frederick William Heaton and Harry Smith, Salford Switch Works, Sidney-street, Salford, Manchester.

7789. An improvement in electric arc lamps. James Brockie, 28, Southampton-buildings Chancery lane, London.

7791. Improvements in electric stop-motions for engines. Louis St Peter. 45, Southampton-buildings, Chancery-lane, London. (Complete specification)

7794. Improvements in shade-holders for incandescent electric lamps. Henry Amyatt Chaundy Hellyer. 53, Chancery-lane, London. (Complete specification.)

APRIL 14.

7834. Improvements in underground systems for electric railways. Alvaro S. Krotz, William P. Allen, and Oliver S Kelly. 5, John Dalton street, Manchester. (Complete specification.)

7854. Improved means for regulating electric motors. Otis Elevator Company, Limited, 55, Chancery lane, London. (Otis Bros. and Co , United States.) (Complete specification.)

7881. Improvements in electric current transformers and method of cooling the same. James Devonshire, 70, Chancery-lane, London. (Walter S. Moody, United States) (Complete specification.)

7882. Improvements in regulating alternating-current electric motors of the induction type. James Devonshire, 70, Chancery-lane, London. (William B Potter, United States.) (Complete specification.)

7883. Improvements in regulating alternating-current electric motors James Devonshire 70, Chancery-lane, London (Charles P. Steinmetz and Ernst J. Berg, United States.) (Complete specification)

7884. Improvements in safety devices for alternating electric current power systems James Devonshire, 70, Chancery-lane, London. (Ernst J. Berg, United States.) (Complete specification.)

7885. Improved compound mould for forming incandescent electric lamp bases. James Devonshire, 70, Chancery-lane, London. (Jacob Henry and August Pederquist, United States.) (Complete specification.)

7896. Improvements in electrical haircutters and singers Frank Merril Bell and James Lundie Sloss, 53, Chancery-lane, London. (Complete specification).

APRIL 15.

7928 Electric signal-indicator. Maunsell Mercier, 5, Deansgate, Manchester.

7973. Improvements in electrical accumulators. Albrecht Heil, 28, Southampton-buildings Chancery-lane, London.

APRIL 16.

8062. Improvements relating to electric railways. Percy William Thomas Davies, 322, High Holborn, London

8067. Magneto-electric governing appliance for steam-engines, water-wheels, and such like apparatus. Reginald Page Wilson 70, Chancery-lane, London.

8068. Magneto-electric regulating and controlling appliance for dynamos and other electrical apparatus, adapted also for indicating and recording purposes. Reginald Page Wilson, 70, Chancery-lane, London.

APRIL 17.

8134. A new or improved electrical welding process. Louis Wimmar Breuer, 37 Chancery-lane, London.

8141. Switch apparatus for electromotors with automatic resistance regulator. Siemens Bros. and Co , Limited, 28, Southampton - buildings, Chancery-lane, London. (Siemens and Halske, Germany) (Complete specification.)

8163. A new or improved alarm clock and apparatus for automatically operating electric signals at definite hours Leonhard Mesmer-Weber, Norfolk House, Norfolk-street, London. (Complete specification.)

APRIL 18.

8169. Electric lighter for incandescent gas lamps. Philip Meyer, 89 Chancery-lane. London. (Date applied for under Patents, etc., Act 1883, Section 103, September 20, 1895, being date of application in United States)

8185. An improvement or improvements in the method of raising or lowering electric light fittings, gas fittings, and the like Percy Garniss Ebbutt, Plume Works, Aston, Birmingham.

8208. A new or improved make of housing or troughing for electric wires. John Row, 55, Market-street, Manchester.

8210. Improvements in means for automatically controlling the carbon feed in electric arc lamps. Henry James Fisher, 70, Chancery-lane, London. (Complete specification)

8216. Improvements in electric motors and dynamos. William Edward Gray, 77, Chancery-lane London.

8234. Improvements in prepayment meters for gas or other fluid, or for electricity. Lewis Sayre Burchard, 4, South-street, Finsbury, London. (Wesley Webber, United States.)

8228. Improvements in armatures for electric generators or motors Siemens Bros. and Co , Limited, and Edward Friedrich Heinrich Hermann Lauckert, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1890

5926 Covering electric conductors. Pitt. (Atherton.) (Second edition)

1894.

13363 Secondary voltaic batteries. Buckland. (Second edition.)

1895.

3864. Electromotors. Sperry.

6565 Electrolysis of chlorides, etc. Tee.

6565a Electrolysis of chlorides, etc Tee.

7075. Electric cooking and heating grills, etc Fletcher and others

8306 Electric batteries Shrewsbury and others.

9708. Electric heaters. Delany. (Amended.)

9796 Electric conduits. Hart and Lucas.

9967 Electric regulators. Moody.

10334. Electric call apparatus Price.

10433. Dynamo-electric generators and motors. Dorman.

10538 Dynamo-electric generators and motors. Dorman.

10596 Dynamo-electric generators and motors Dorman.

11025 Electrically working railway switches and signals. Siemens Bros. and Co , Limited. (Siemens and Halske.)

11726 Incandescent lamps Perlich.

15114. Electric current meters Erben and Bergmann

20801. Electrically lighting gas-jets. Von Morstein.

20924. Electric annunciators. Thompson. (Higgins.)

1896.

2915. Electric gas igniting and extinguishing apparatus. Czarnikow.

4076 Incandescent electric lamp-holder. Thompson. (Porzellanfabrik Kahla, Filiale, Hermsdorf-Klosterlausnitz.)

4238 Dynamo-electric machines and motors. Devonshire. (Knight.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1¾ 1⅞
—— Non. Cum., 6 per cent. Pref.	2	1⅜-1⅝
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	7½-7¾
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7⅞-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	16½-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	12¼-13¼ xd
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2½-2⅝
Edison and Swan United Ordinary	3	1½-1⅝
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	1⅝-1⅞
—— 7 per cent. Cumulative Pref.	2	2⅛-2¼
Elmore's Copper Depositing	2	⅛-¼
Elmore's Wire Company	2	⅛-¼
Fowler-Waring Cables	5	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	16½-17½
—— 7 per cent. Preference	10	16½-17½
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	3⅛-3½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	—
Kensington and Knightsbridge Ordinary	5	8½-8⅝
—— 6 per cent. Pref.	5	7½-7⅝
Liverpool Electric Supply, Ordinary	5	7⅝-7⅞
Liverpool Overhead Railway	10	14½-14⅝
—— 5 per cent. Pref.	10	16⅝-16¾
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	⅜-½
Metropolitan Electric Supply	10	13-14 xd
—— 4½ per cent. First Mortgage Debenture Stock	100	119-120
National Telephone, Ordinary	5	7-7½
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6⅝
—— 3½ per cent. Deb. Stock	100	106-109
Notting Hill Company	10	9-9½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8⅝
—— £4½ shares	4½	7½-7⅞
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4⅞-5½
St. James's and Pall Mall, Ordinary	5	10½-10⅝
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	6	8½-8⅝
Westminster Electric Supply, Ordinary	5	9⅜-10½
Yorkshire House-to-House	5	7-7½

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NOTES.

Institution of Electrical Engineers.—There is to be a students' visit to the London Electric Supply Corporation's station at Deptford on May 9. Students desiring to take part in it should communicate with Mr. Allingham.

Berlin Exhibition.—The Association of German Electrical Engineers, in conjunction with the Association of German Engineers and the Electrical Association of Berlin, will have a meeting room for members and visitors at the Berlin Exhibition.

Scots Engineers and Shipbuilders.—We have received a copy of the *Transactions* of the Institute of Engineers and Shipbuilders in Scotland. It contains Mr. Stewart's paper on welded iron and steel pipes and Mr. Beardmore's paper on nickel steel.

Motorcarts.—Lord Harris's Bill on the subject of self-propelled vehicles on roads passed its second reading in the House of Lords last week. The fixing of the maximum weight for electric carriages under the Bill is to be considered, as the two-ton limit is too low.

Personal.—Mr. Walter A. Poynton is about to leave the Electrical Power Storage Company in order to take up the position of assistant engineer at the Hôtel Cecil, now about to be opened, the lighting of which alone involves the installation of generating plant upon a by no means small scale.

Search-Lights at Sea.—Admiral Henry Boys presided on Wednesday at the Royal United Service Institution, Whitehall, when Mr. B. Tower described an apparatus for providing a steady platform at sea for search-lights, etc. We proposed to give Mr. Tower's lecture in full in a future issue.

The City and the Telephone Company.—An application of the National Telephone Company for permission to lay cables under certain thoroughfares in the City was considered at a meeting of the City Commissioners of Sewers last Tuesday, and it was decided to refuse the application, on the ground that the company was not prepared to make any concession for the public benefit in return.

Hydraulic Engines.—In connection with the Society of Engineers Mr. Arthur Rigg is to read a paper at the Royal United Service Institution on May 4 on the subject of hydraulic rotative engines. Mr. Rigg intends to remark on the fact that while great literary attention has been given to turbines, the hydraulic engine has been comparatively neglected and remains without anything equivalent to the care which has been bestowed on improvements in the steam-engine.

Stamping Patent Forms.—Mr. Jackson, M.P., who has been in correspondence with Sir H. Reader Lack, the Comptroller of the Patent Office, with reference to the stamping of patent and other forms at Inland Revenue offices in the provinces, has received a letter informing him that the Board of Inland Revenue have authorised their officers at Leeds to stamp in future any patent, design, and trade-mark forms which may be presented to them by the public for that purpose.

Beryllium.—Judging by suggestions made on the subject, some people lately have been desirous of getting beryllium (glucinum) used in some way in electrical work. Up to the present, its light weight and high conductivity have been mainly insisted upon, but it is now stated that its coefficient of expansion is the same as that of platinum, and therefore it could be used instead of the latter in incandescent lamps. There is, however, the lower melting point of beryllium to consider before that is done.

Telegraph Poles.—In advocating the adoption of Wohl's system of preserving the bases of telegraph poles by socketing them and surrounding them with cement, the *Elektrotechnischer Anzeiger* estimates that the telegraph poles of the whole of the European Continent represent a value of more than £10,000,000, and that the yearly cost of renewals runs up to a million. Any improvement on the existing practice which would give a longer life to the pole must therefore result in an aggregate saving of an anything but inconsiderable amount.

Carriage Manufacturers.—The summer meeting of the Institute of British Carriage Manufacturers has this year been fixed to be held in London. The conference will open on Tuesday, June 23, when the members will be received by the Lord Mayor at the Mansion House, where the president's address will be delivered. In the evening the members will dine at the Holborn Restaurant, and on the third day, by special invitation of the directors of the Crystal Palace Company, the members will visit the International Horse and Horseless Carriage Exhibition.

Direct West Indian Cable.—In the House of Commons last week Mr. Chamberlain, in answer to a question from Mr. Tomlinson, said he had received communications from the West India Colonies, representing the importance of establishing a through telegraph communication between this country and those colonies, for the purpose of Imperial defence, as well as for commercial purposes. He had no reason to think that there are any insuperable difficulties in effecting any such communication, and proposals on the subject were under consideration, which he hoped would result in a cable being laid at no distant date.

Naval Architects.—The summer meetings of the Institution of Naval Architects will be held this year in Hamburg, on Monday, June 8. On Wednesday, June 10, the meetings will be transferred to Berlin, on the invitation of the Imperial German Government, and they will be continued there during the remainder of the week. Particulars of the papers to be read, of the works and places of interest to be visited, and of the excursions and entertainments which are being organised, will be forwarded to the members on or about May 23. The meetings are receiving the warmest support from the Imperial Government, under whose direction the arrangements in Berlin are being prepared.

Cable Interruptions.—From the monthly list of interruptions of telegraph lines given in the *Journal Télégraphique* of April 25 it appears that the Jersey-to-Guernsey cable was interrupted from April 8 to 21. The Gwelo-Salisbury and Beira lines in Rhodesia and Portuguese East Africa failed on April 2, and communications were not restored when the list was compiled. The Aden-Zanzibar cable, which broke down on March 16, was restored on March 22, too late to be included in last month's list. The interruptions of the Brest-St. Pierre cables are now of long standing, as is also the interruption of the Nicaraguan land lines. Other breaksdown were of less than one day's duration.

Cantor Lectures.—On Monday last Mr. James Swinburne gave the first of four lectures on "Applied Electro-Chemistry." At the commencement of his lecture Mr. Swinburne explained that what he said and what he wrote for publication in the Society of Arts *Journal* would be two different things, and that reporters, if any, had best go quietly away. We did not notice that any reporter

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left, but we quite agree with Mr. Swinburne that what he said was unreportable. The larger part of the lecture consisted in showing simple electrolytic experiments, with a short digression into the mysteries of thermal electricity, and, finally, a comparison of Grottius's views of electrolytic action and the modern views of the travelling of the ions.

The Metric System.—Although the Government have thrown over the committee's recommendation for the adoption of the metric system, the *Times* has published yet a fourth article on the subject, and summed up the whole question in a leader. So that that matter is done with—for the present. There has, however, been an aftermath of letters, including a curious one from Mr. E. Le Clerc. Part of this the *Times* translates and prints in English, part it gives in the original French, apparently because Mr. Le Clerc goes out of the way to be impolite to people that have certainly nothing whatever to do with the matter. This simply excites curiosity as to what might be contained in a third part, which the *Times* apparently judged it undesirable to publish. A letter from Lord Kelvin makes the practical point against a duodecimal division that no one ever asks for thirds of anything. They do not for fifths either, so far as that goes.

Zurich Tramway.—The Centrale Zurichbergbahn is a line about a mile and a half in length with severe gradients, and with curves of as little as 18 yards radius. It is worked on the overhead electric system, but the most noteworthy thing about it is that, instead of a steam plant, the power supply at the generating station is derived from Crossley engines and Dowson gas. The plant is in duplicate—that is, two sets of producers and engines. The latter are about 50 h.p., and are belted to the dynamos. These are four-pole compound-wound Oerlikon machines, and are worked in connection with an accumulator, a supplementary dynamo being provided for charging this. The voltage is 550. The plant has been working about nine months, but no figures are at present available to show whether a superior economy has actually been realised over what could have been obtained by the use of steam-engines. It is, however, understood that the management consider the working and results to be satisfactory.

Carbon Resistances.—The *Elektrotechnischer Anzeiger* of the 12th inst. contains an article on the use of retort carbon as a material for the manufacture of resistances on a principle the patent for which is held by the Vienna Sirius Fabrik. A metre length of carbon of one square millimetre cross-section would give a resistance of about 75 ohms at 0deg. C., with a temperature coefficient of ·00052, its specific resistance being nearly 80 times greater than that of manganese-copper. As an example of apparatus of this kind an illustration and description is given of an adjustable resistance for arc lamps. This consists essentially of a quantity of the best round lamp carbons of the customary length arranged between two slate plates in such a manner as to permit of expansion, and with the necessary connections. The whole is covered with a perforated metal screen. Our contemporary considers that there should be a place for apparatus of this class in alternating-current work, since, owing to the short length required and the avoidance of the coil form, self-induction is obviated.

Iron and Steel Institute.—The following is a list of the papers which will be discussed at the meeting of the Iron and Steel Institute, to take place at the Institution of Civil Engineers on May 7 and 8: "The Rate of Diffusion of Carbon in Iron," by Prof. W. C. Roberts-Austen, C.B., F.R.S.; "Alloys with Iron Carbides," by J. S. de Benneville (Philadelphia); "Mond Gas as applied to Steel-making," by John H. Darby (Brymbo); "Hot-Blast Stoves," by B. J. Hall (Westminster); "The Hardening of Steel," by H. M. Howe (Boston) (adjourned discussion); "The Introduction of Standard Methods of Analysis," by the Baron Hanns Jüptner von Jonstorf (Neuberg, Austria); "The Production of Metallic Bars of Any Section by Extrusion," by Perrey F. Nursey (London); "Mr. Howe's Researches on the Hardening of Steel," by F. Osmond (Paris); "The Treatment of Magnetic Iron Sand," by E. Metcalf Smith (member of the New Zealand House of Representatives); and "The Making of the Middle Lias Ironstone of the Midlands," by E. A. Walford, F.G.S. (Banbury). The Bessemer gold medal for 1896 will be presented to Dr. Hermann Wedding, of Berlin; and the annual dinner of the institute will take place at the Freemasons' Tavern on May 7.

A New Use for Telegraph Poles.—As will be remembered by those of our readers acquainted with the early history of telegraphy, the capture of a criminal through a message sent by the newly-invented apparatus did a good deal towards bringing the telegraph before the authorities. Since then very many gentlemen urgently "wanted" by the police have been secured by its means, so that there is reason to believe that electrical progress has always been regarded with little favour in criminal circles. The final step was thought to be reached when electro cution was adopted in America. The Liverpool police have, however, added another round to the ladder, and at the same time have outrivalled the most elementary prison arrangement described by Mark Twain. Two men were recently discovered in Liverpool while in the act of removing the gas-pipes and internal fittings from some unoccupied buildings. An exciting chase ensued over the roofs of a high warehouse and other buildings. One man was caught and handcuffed to a telegraph post, the two policemen being thus free to chase the other man, who was eventually caught. The remarks of the man as he remained embracing the telegraph post are not recorded, but we understand that they took the form of a petition to the Government on the advantages of underground wires.

The Paralleling of Alternators.—It is sad to note how much the American Press excels that on this side of the water in so far as concerns the superabundant knowledge of its editorial staffs. Up to the present we had thought that both the practical and theoretical knowledge of the parallel running of alternators had its origin on this side of the Atlantic. Our New York contemporary *Electricity* has, however, given publicity to an American development which should, if true, upset all our present arrangements. The editorial statement is as follows: "It is a curious fact, observed in this country but not mentioned in Mr. Hammond's paper, that two alternators coupled in parallel will continue each to contribute its share of current even though the field excitation of one of them is stopped. The E.M.F. will drop somewhat, but they will each continue to do its own proportionate part of the total work, so strong is the tendency of properly constructed alternators to keep in step." These facts are much too deep to admit of ordinary explanation, and we would respectfully suggest either that the properly-constructed alternators had permanent magnetic fields, or else that the "fact" came from the heated brain of a commercial traveller engaged in competition with a rival for a large order. Enlarging on this new departure, we suppose that in a large alternate-current station it will be quite sufficient to excite one alternator only.

Geneva Exhibition.—Writing on the subject of the Swiss exhibition, the *Revue Industrielle* observes that the Swiss engineers will not let slip the opportunity of showing what they can do and of justifying the reputation they

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have already acquired. Under the auspices of the Swiss Society of Electricians, an international congress will form an occasion for the meeting of all the electrical celebrities of both the New and the Old Worlds, and the discussions between men of science, engineers, and manufacturers, and the excursions made in a country so largely endowed with sources of water power, will hasten the practical solution of the problems attached to the transport and distribution of energy over great distances. But our contemporary adds: "On the programme of questions to be considered at the congress we find neither lighting nor electro-chemistry figure. These are worn-out and somewhat monotonous subjects, although the fight between continuous and alternating currents for the utilisation of power derived from waterfalls might still admit of the presentation of original views both on the theoretical and the commercial side of the question. For the professors both present and future is reserved the supreme pleasure of disserting once more on magnetic and photometric units without coming to any agreement on the subject, but we hope that they will have the politeness, as they did in the United States, to invent another new unit in order to christen it with the name of a Swiss electrician."

Surface Leakage.—The testing of the insulating properties of different materials is usually complicated by leakage round the surface of the article experimented on, and unless this is provided against it necessarily vitiates the results. A novel way of eliminating the leakage current from the current passing through the material has been devised by A. Monell, and is described in *Electric Power*. The insulating material to be tested is wrapped on a brass cylinder 1½in. diameter and 4½in. long, the insulation not reaching quite to the end of the tube. Over the insulation is wound a layer of No. 24 B.W.G. copper wire, forming an envelope 2½in. long over the centre of the insulation. Between this and the two edges of the insulation a few turns of wire are wound on each side. The few turns are spaced so as to be equidistant from the ends of the 2½in. coil and the ends of the insulation. The test is then made by determining the current that flows between the brass tube and the coil of wire with a given voltage. The few turns are connected to the opposite pole to the brass tube, which practically shunts past the galvanometer the surface leakage current. The above method is stated to give most satisfactory results, but we should imagine that care must be taken when investigating the properties of material of comparatively low specific resistance. Then if the difference of potential in the galvanometer terminal is fairly large, the shunting effect of the leakage between the 2½in. coil and the protecting coils would be appreciable.

London Tramways.—In reference to the proposal to amalgamate the London tramway systems, the *Times*, in its City article, says that there can be little doubt that sooner or later electric traction will have to be adopted for London, as it has been for many other cities, especially in the United States. Cars driven electrically occupy less space than horse cars; the streets in which they run are cleaner; speed can, on the average, be greater, and there will, consequently, be less hindrance to other traffic. It is considered that a syndicate would be better able to raise the capital necessary for conversion to electric traction than the present companies, and it is pointed out that so far as concerns the general public "the essential thing is that the opportunity now offered for securing a consolidation of the present chaotic tramway system should be utilised. It does not matter to the public whether the work is done by this syndicate or some other, by the companies or by the County Council itself, but it seems to us that any scheme by which the present piece-meal administration would be perpetuated ought to be rejected." It is added that the syndicate offered to carry out the work of uniting the two systems of lines north and south of the river by a line over Blackfriars Bridge. The benefits which this unification would produce need not be dwelt on, but hitherto there has existed a strong objection to allowing tramways to run over bridges in London, though this is permitted in most other cities of the world. The syndicate, however, would be prepared to put the line down at their own expense experimentally and take it up again whenever ordered to do so without any compensation.

Overhead and Accumulator Traction.—In an electric tramway running into a town the terminal part of the journey may often be through comparatively narrow streets, where the poles and wires of the overhead system would prove inconvenient, or where, for other reasons, their erection may be forbidden by the local authorities. Under these circumstances, an obvious expedient is to finish the journey with accumulators. It, therefore, becomes desirable to work out the most rapid and convenient method of effecting the transition from the wire to the battery, and for replacing the latter when exhausted. This is a matter which is very closely connected with the position the accumulator occupies on the tramcar. A usual place for the cells has been under the seats. This has the advantage of keeping the weight low down, but is clearly unsuitable for the present purpose. A plan has been worked in Germany by which the charged accumulators run on small trucks, and are shunted on to the track and attached to the cars where the overhead wire ends. Another system is now described in the *Elektrotechnischer Anzeiger*, in which the cells are placed on the roof of the tramcar. One end goes at once to the base of the trolley arm, and the only other connection necessary is a conductor from the negative terminal to the other side of the motor. The cells are charged on what may be called the first floor of the substation building, and run out of a window at the level of the roof of the tramcar. Inside the building a turntable and sets of rails form a convenient means of getting the cells to suitable positions for charging them.

Acetylene and Copper.—On the subject of the possibility of acetylene forming an explosive compound on contact with copper or brass fittings, the *Revue Industrielle* says that the fear of copper acetylide is the beginning of safety, but as a matter of fact the above-named explosive compound does not occur as easily as has been supposed. Our contemporary considers that there is reason to believe that the true explanation is that the presence of at any rate a small quantity of ammonia is necessary to obtain the formation of the acetylide. The composition and properties of acetylene occupied a great part of Prof. Dewar's last week's lecture at the Royal Institution. It was, he remarked, a very explosive gas, "going off" at a much lower ignition point than coal-gas when mixed with a little air, and, what is more remarkable, it would often explode on its own account (without air) if submitted to shock or concussion. Still, with care it can be used safely enough. Another of its characteristics was that at 83deg. C. below zero it turned straight from gas into a sort of paraffin wax, without troubling to pass through the intermediary liquid stage, but the solid could be subsequently liquefied by heating under pressure. Referring to the use of the electric furnace, Prof. Dewar remarked that it had enabled us to complete the synthesis of the organic chemical compounds. From the carbides, prepared in the electric furnace, we can get benzine (and therefore all the aniline dyes), and even crude petroleum. Again, acetylene combines directly with nitrogen in the

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presence of an electric discharge, and gives prussic acid. From this we can easily get cyanides, which, treated red hot with steam, yield ammonia. In fact, the chemist sees no end to the sphere of usefulness of the electric furnace, which may even solve the problem of making nitrogenous manures.

The Purchase of the Telegraphs.—The quarrel as to the proper way of bringing into account the interest on the money spent on purchasing the telegraphs still goes steadily on, and seems likely to last until the Government has to purchase the telephones also. In the House of Commons on Tuesday Mr. Henniker Heaton asked the Secretary to the Treasury whether, in regard to the telegraph debt of £10,130,000 and the suggestion to pay it off, his attention had been called to the statement made on page 37 of the forty-first annual report of the Postmaster-General for 1895, that during the year ended March 31 last the expenditure exceeded the revenue by about £154,000, to which must be added the interest (£298,000) on the capital expenditure incurred at the transfer, making the total loss for the year about £452,000; that in the period of 25 years since 1870 the receipts showed a balance of about £1,795,000 in excess of the expenditure, but that they fell short of meeting the interest on capital, the aggregate deficiency in this respect being £5,859,000. In reply to this Mr. Hanbury said the corrected figures gave an excess of expenditure over revenue in the year to March 31, 1895—not March last—of £141,637. 12s. 7d. The Post Office was not aware that any proportion of the moneys applied to the reduction of the National Debt had been ear-marked as a fund for paying off the stock created for the purchase of the telegraphs. Any separate and specific treatment of the telegraph capital would, it is feared, have resulted in its being increased rather than reduced. In a sense the working of the telegraphs had itself hindered the reduction of the National Debt, for it had added to it more than £10,000,000. If, therefore, a strict balance-sheet of the working of the telegraphs was prepared the outstanding debt would not be between 10 and 11 millions, but would be about 16 millions.

Telephoning to Trains.—Some experiments recently tried by Mr. K. L. Martin, assistant engineer on the New York and Brooklyn Bridge, in the way of establishing telephonic communication between moving trains, and between trains and the train dispatcher's and bridge offices, have been described in the *Scientific American*. The necessity of some adequate method of train communication and signalling in cases of fog or some emergency has been felt on the bridge, but there have been difficulties in the way of establishing telephonic communication with moving trains that have prevented it from being put into practice, but which it appears have now been overcome, so that it is now possible to communicate with moving trains with almost the same facility as between fixed points. The Brooklyn Bridge is provided with a trolley wire for electrically lighting the trains. This wire, which was used in the telephone experiment, was connected with the train dispatcher's office and with the bridge offices, and upon the cars were placed arms provided with compound brushes which touched the trolley wire. The circuit was completed through the car truck and track rail, the connection between the circuit wires and truck being completed by a brush resting on one of the car wheels. The compound brush consisted of a number of brushes of brush copper fastened together with intermediate pieces of soft rubber. The brushes being electrically connected with each other and with the telephone wire, arranged in this way, unbroken onversations could be carried on while the trains moved along. It is stated that the electrical contact of the compound brush with the trolley wire was so perfect that the sliding of the brush on the wire produced no noticeable effect. It is proposed to permanently equip the cars with telephones and to provide a suitable electric conductor on the bridge in convenient position for contact with the brushes carried by the cars.

The Nature of Electrolysis.—If, for instance, potassium and chlorine are brought together and unite, a very large amount of energy is given off, and it may be accepted that they cannot afterwards be separated without the expenditure of an equal amount of energy to that which was produced by their combination. Nevertheless, according to recent theories of the nature of electrolysis based on the discoveries of Arrhenius and Van t'Hoff, when potassium chloride is dissolved in water its molecules (or at least a proportion of them) are dissociated, not merely into potassium and chlorine molecules, but into actual atoms. It therefore becomes necessary to explain how the energy for this process is obtained. In the course of a paper, mainly historical in character, read by Dr. J. W. Richards at the Franklin Institute, Philadelphia, the suggestion is made that the atoms are really united by as great a force after dissociation as before, only it is electrical "force" instead of chemical "force," and as chemical "energy has been replaced by electrical energy, it is a case of conversion of energy," and therefore no additional energy need be supplied for the process. What follows, however, is by no means so clear—namely, that "since the atoms are no longer held together by the force of chemical affinity, they will be free to act as if chemically independent of each other—*i.e.*, as independent atoms." (This is necessary to explain the properties of the solution.) And also, since the atoms are "held together by electrical instead of chemical energy, they are susceptible of being separated by a counter electric force." The anomalous use of the words "force" and "energy" being allowed for, this may, or may not, be a statement of what really occurs, but in spite of a mechanical analogy given by Dr. Richards it is a little difficult to form a mental picture of the precise change that is assumed to take place. Indeed, until there is some clear theory as to the nature and difference between the electrical attraction of the atoms and chemical affinity—if, indeed, they are not parts of the same thing—an explanation of this character may very easily degenerate into a mere play on words.

Fenders and Brakes.—The Americans have had much more experience than we have in England in the matter of running electric tramcars, but they have by no means settled all the problems connected with it. On this subject *Electrical Industries* remarks that in the United States "the fender, although by some city governments the company is forced to furnish them on cars, has never been popular with the companies, and will probably never become universal. It is but a modification of the 'cow-catcher' of the steam locomotive, whose duty it is to throw the cow from the track regardless of what injuries the cow may receive. Inventors have placed springs and cushions of all kinds on frameworks of curious designs with the idea that the victim would be carefully picked up and held as gently as an infant in its mother's arms, no matter at what speed the car might be going, or in what position he might be in when the car reached him. Some railway managers have wisely grasped the situation, and have watched the improvement in car brakes as a solution of this problem. On the old horse-cars hand-brakes were satisfactory, and met all requirements of the service. They passed out of date however, with the street-car horse, and have on modern cars been a constant reminder of that antiquated method of transportation. Steam roads long ago discarded hand-

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brakes for their passenger trains, and the freight cars are now being rapidly equipped with the more efficient and serviceable air-brake. The enterprising manufacturer has adapted this form of brake to the service of the street car, both electric and cable. Their works are now busy filling orders for the progressive railway companies, who see in this form of brake a remedy for many of the defects of the present railway system. A less number of accidents, faster time, more efficient service, and an entire equipment corresponding to the progressive age in which we live are some of the advantages of this type of brake for street railway cars." As to this, any mechanical brake is doubtless better than a hand-brake, in so far as it is more powerful and quicker in action, but the great advantage of the "air-brake" on a railway train is that it affords a means of braking all the carriages from any one of them, but it does not follow that this form of brake will retain its superiority when applied to cars which only run singly, as tramcars do.

Rontgen Radiations. — Although, unfortunately, much valuable time and trouble has been wasted by experimenters simply duplicating each others' work, additional knowledge is gradually being acquired as to the nature and properties of the new radiations. From the American technical Press it appears that Prof. O. N. Rood, of Columbia University, New York, has succeeded in reflecting Röntgen rays from a surface of platinum foil at angular incidences, but even at 45deg. only about $\frac{1}{2}\frac{1}{5}\frac{1}{0}$th, so nearly as can be judged, is reflected. Hitherto reflection has only been obtained at practically grazing incidences. This is hardly the place to go into questions of molecular constitution, but it would be interesting to know whether any results can be obtained in this way with mercury or even lead. In reference to the theory of the matter, nothing comes forward in support of the longitudinal hypothesis, and there is already some, though not much, direct evidence against it. It will be remembered that radiations obtained from the fluorescence of potassium uranyl salts have most, if not all, of the properties of the Röntgen rays. It now appears that these radiations can be polarised by tourmaline with all the usual phenomena, which at once establishes the transverse character of the vibrations and shows that vibrations of that character are capable of doing all that is necessary to explain the phenomena observed. The direct evidence in favour of the longitudinal wave has hitherto been confined to some rather fine-drawn conclusions derived from a comparison between the action of the Röntgen radiations and ultra-violet light in discharging a condenser or electroscope. The argument never seemed to us to have any weight whatever, but anyhow it has been destroyed altogether by an observation of Prof. Röntgen himself, who, it appears, as the result of most careful experiments, has ascertained that at any rate a gaseous dielectric remains "leaky" for an appreciable time after the action of the radiations on it has ceased. The effect, therefore, is a molecular one in the dielectric, and can have no special direction quality. It looks very like a case of quasi-dissociation, and may some day throw light upon the very vexed questions of electrolysis and gaseous discharge. Lastly, it has been objected against any wave theory that it is impossible to get interference fringes with the new rays. It has now been ascertained that as the exhaustion of the vacuum tube is increased the character of the radiations greatly changes, so that, for instance, from the same tube at different exhaustions radiations may be obtained to which bone is respectively transparent and opaque. This shows that the radiations are far from being homogeneous. Now with ordinary light, the range of which is well inside one octave, the fringes are a colour rather than an intensity effect, and their number is strictly limited. If, therefore, the Röntgen rays are made up of undulations of widely differing wave-lengths, any attempt to get interference phenomena will be exceedingly difficult, not to say hopeless, until there is some means of separating out what are practically "monochromatic" radiations.

Thermo-Electric E.M.F.—In a thermo-electric circuit in which one of the junctions is at a temperature of h and the other at a temperature of c degrees on the ordinary centigrade scale, the E.M.F. in the circuit due to the difference of temperature is a function of h and c, which, whatever its form may be, will involve constants depending upon the nature of the metals. The discovery of the form of this function is not only a matter of scientific interest, but is needed for such a practical matter as the satisfactory calibration of a pyrometer. About five empirical forms have been proposed. The first is a series of ascending powers of the absolute temperature with arbitrary coefficients, one of the junctions being assumed at zero. For the two temperatures the difference of the series is used, and the terms are of the form $N(h^n - c^n)$, h and c being, of course, absolute and not centigrade temperatures. As a matter of fact, however, only two terms are used, and as there is obviously no constant term the expression becomes a simple parabolic one. Avenarius, Thomson, and Tait have proposed forms involving essentially products of the sum and difference of the temperatures with the addition of constants, and which therefore reduce to the same thing. The Barus formula is an exponential one. In the issue of the *Proceedings* of the American Academy an account is published of the work done on this subject by Mr. S. W. Holman in connection with the Rumford fund. Mr. Holman has been endeavouring to find a formula which will give more correct results than any of the above. In passing, he remarks that "there seems to be little hope of arriving at a close approximation to the natural law except through an expression which shall contain separate terms representing the temperature function of the component arising at the contact of the dissimilar metals and that arising from the inequality of temperature at the ends of each (homogeneous) element (the Thomson effect)." The parabolic formula would comply with this if the contact E.M.F. varied as the first power and the Thomson E.M.F. as the square of the temperature, but in that case the neutral point would have an explanation different from that usually accorded to it. Mr. Holman, however, proposes for practical work to represent the difference of the E.M.F.'s of the hot and cold junctions by the difference of powers (not integral ones) of the temperatures in each case multiplied by a constant. As the cold junction is usually kept at one temperature—*i.e.*, 273deg. absolute or 0deg. centigrade—the expression for the E.M.F. reduces to $m\,t^n - b$, where t is the absolute temperature of the hot junction and m, n, and b are constants. Mr. Holman does not advance this expression as a possible natural form of the function, but states that it very closely fits the experimental data. That it should do so follows from the known adaptability of the exponential equation to represent limited portions of any curved line. On the basis of this formula, Mr. Holman proceeds to work out interpolation and extrapolation formulæ for graduating a pyrometer, which lead in the case of a Le Chatelier pyrometer to a logarithmic instead of a direct plot. He also shows that his formula gives results more in accordance with known data than any of the others at present in use. He, however, advocates the establishment of a standard based on the melting points of inexpensive metals, with a possible system of simple alloys to give points of sufficient frequency as pyrometric "bench marks."

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CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXIX.

(Specially Contributed.)

How to Obtain the Best Effect.—Faraday in his first apparatus supplied the most efficient form of machine that could be devised. All our modern investigations have not led us to find a flaw in its perfectness so far as form is concerned. Unfortunately, for many purposes, in practice this apparatus can only be used in a secondary sense. By it we cannot transform other energy into electrical energy. Its use is, when we have obtained electrical energy by other means, to harness that energy so as to utilise it for a particular purpose. An examination, however, of this practically almost perfect machine will assist us in determining the gradual progress of the various types of machines towards economy from the time of Faraday till the present day. Not only does Faraday's apparatus give the best effect, but it gives us

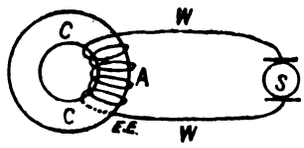

FIG. 1.

the means of measuring that effect. In Fig. 1, suppose S represents a source of electricity, W W all the wire connections carrying current to the coil, A, while C C is a complete ring of iron forming the core of the coil A. We have seen that when a current is passed through the coil magnetic lines of force are formed in the core. The number of such lines is indicated by the formula $L = \frac{P}{R}$. Now P depends on the current through the coils and the number of turns in the coil. We can easily measure the current through the coil by putting an ammeter, G, in that circuit, as in Fig. 2.

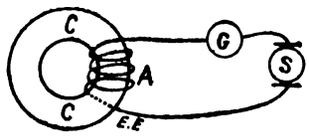

FIG. 2.

Suppose a current of one ampere is shown on the ammeter, then a current of one ampere goes through each turn of the coil, and by counting the number of turns we know the number of ampere-turns. The ampere-turn is, as we have seen, taken as the unit of magneto-motive force, then the number, n, of ampere-turns measures the total magneto-motive force, or magnetic pressure used to generate the lines of force

It is fairly easy then to obtain a constant magneto-motive force.

It is not so easy to obtain a fairly constant magnetic resistance.

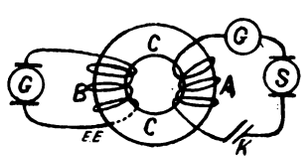

FIG. 3.

It is fairly easy to compare magnetic resistances. Upon the core, C (Fig. 3), wind another coil, B, and connect preferably to a ballistic galvanometer, G_1. Call the coil A the primary coil, and the coil B the secondary coil. In the circuit of the primary coil put a key, K, to make and break the circuit. In such experiments as these the best source, S, is perhaps a good secondary battery.

Make the primary circuit and note reading of ammeter, G. There is induced in the secondary circuit a current whose value is shown by the deflection of the galvanometer, G_1.

Now change the core, C C, for iron of another kind or of another maker, and repeat the experiment, keeping current through primary the same as before.

The result will probably be a different reading of G_1, showing either a greater number of lines of force loop round the secondary coil—that is, go through the new core—or a less number.

If you take half a dozen different makes of iron, fashion them as nearly as possible into cores of similar length and sectional area, it will be found that each core differs somewhat in magnetic resistance to the other cores.

Hence, the core increases or decreases in **permeability** - that is, to the property of stopping or passing through lines of force—and this greater or less permeability depends upon the **reluctance**, or resistance, of the core. The greater the reluctance the less the permeability, and the less the reluctance the greater the permeability. The properties are, therefore, in inverse ratio to each other, but the whole thing is the same as saying, the greater the resistance the less the number of lines of force, and the less the resistance the greater the number. I am old-fashioned enough to prefer the common everyday words, that clearly explain themselves to any of the new-fangled words, which are not introduced to simplify, but to obscure. To resume:

If the primary and secondary circuits were alike as to the number of turns in coils, to resistance, etc., then G_1 would momentarily indicate like G—if *all* the lines of force took the path of the core; but they don't. The iron core path is the path of least resistance, but there are other paths, and some of the lines—not many in the case of a complete ring of the best iron—do leak and have no effect, or an adverse effect, on the secondary coil or on galvanometer, G_1.

The galvanometer, G_1, allows us to measure the effect of *all* the lines that loop coil B.

To continue our experiments. Take any one of the cores, C C.

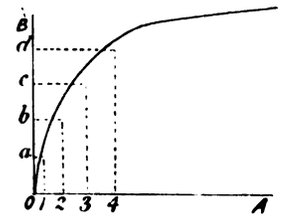

FIG. 4.

1. Let a current of one ampere go through primary, and note effect on G_1.
2. Let a current of two amperes go through primary, and note effect on G_1.
3. Let a current of three amperes go through primary, and note effect on G_1.

And so on.

We can show the effect by means of a diagram, Fig. 4.

Let O A represent the magnetic pressure;
„ O B represent the lines of force evoked by the pressure.

We find that at first the number of lines increase almost in proportion to the pressure—that is, if we double the pressure (ampere-turns) the number of lines of force are double. Thus, 20 ampere-turns give double the effect of 10 ampere-turns.

By increasing the pressure we soon find that the number of lines do not increase proportionally, and increasing the pressure still further, we find that the additional increase hardly alters the number of lines. This result goes far to prove my contention previously expressed, that *each line of force* (by this, of course, I mean the phenomenon we have agreed to represent by a line) *occupies space* to the exclusion of any other line of force from that space. Thus, when the space—that is, the sectional area of the iron—contains no lines the number evoked is proportional for small pressures. When, however, the space is full, increasing the pressure will not, it cannot, put more lines into that space. The point when increased pressure does not increase the number of lines is termed the *point*

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of saturation of the iron. If we select as a unit for measurement one line per square centimetre, this will give us 6·45 lines per square inch, because one square inch = 6·45 square centimetres. Prof. Ewing, F.R.S., has forced 45,300 lines per square centimetre, or 292,185 per square inch, through iron, but only under exceptional circumstances. Usually, 16,000 to 20,000 lines per square centimetre—that is, 103,200 to 129,000 per square inch—is the value mostly used in the construction of dynamos.

Now, whatever be the number of lines looped through a coil, we know by the indications of our galvanometer they have a twofold effect—one effect on being looped through the coil; an equal and opposite effect on being unlooped through the coil. These two effects have always to be considered when discussing the effects of lines of force upon conductors.

Thus when we close the circuit (Fig. 3) we get an indication on the galvanometer, G_1—that is, the needle swings through a certain number of divisions of the scale. If we keep the key, K, depressed—that is, if we keep the primary circuit closed—the needle of the galvanometer in the secondary circuit will return to zero. If, now, we break the primary circuit, the needle of G_1 will indicate a current of equal strength but in the opposite direction to that indicated on making the circuit.

Now to continue our experiments, but this time with cores not iron. Try cores of the same dimensions as those of iron, but constructed of wood, ivory, paper, glass, etc. On making the primary circuit we shall find an indication of current in the secondary, and this indication will be almost the same whether we use wood, ivory, paper, glass, or nothing at all except air. The indication in G_1 is, however, very small compared to what it was when the iron ring formed the core. In other words, the resistance of the path through the secondary coil has been largely increased, and the number of lines looped around it correspondingly diminished. Iron, as I have said, is our best and nearly our only magnetic conductor. Cobalt and nickel are the other magnetic conductors, though far inferior to iron. If a little manganese be mixed or alloyed with iron, we get a material almost non-magnetic. Iron, then, usually forms the core upon which we wind the coils of the secondary to be acted upon by the lines of force.

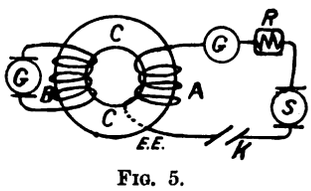

Fig. 5.

There are two more sets of experiments to examine. Into the primary circuit we put this box of resistances, R, Fig. 5. The resistances are so arranged that by adding them to the resistance of the rest of the circuit the total resistance will be about doubled.

1. Make circuit with no extra resistance in, and note deflection of G_1.
2. Break circuit with no extra resistance in, and note deflection of G_1.

Deflection of G_1 is found in No. 2 case to be equal and opposite to No. 1.

3. Repeat No. 1, keep key down, and let needle of G_1 come to rest.
4. Put extra resistance into primary circuit and note G_1.

Deflection of G_1 will be about half what it was in No. 2, but in the same direction as No. 2. Let G_1 come to rest.

5. Break primary circuit by key. Note G_1.

Deflection of G_1 is about same and in same direction as No. 4.

The sum of deflections No. 4 + No. 5 will equal deflection No. 2.

This shows that the total effect of taking out lines of force will be the same whether they are all taken out at once or at separate times. Thus, supposing No. 3 caused a looping through secondary coil of 10,000 lines, experiment No. 4 gets rid of 5,000 lines with a certain result, and experiment No. 5 gets rid of the other 5,000 with a similar result; the sum of the two results is the same as if the 10,000 lines had been taken out at once.

For my second series of experiments I must slightly modify Faraday's ring. C C, the core of coil, B, Fig. 6, is made up of a number of similar half rings of soft iron, and I can take one or more or all those half rings away as I please. Taking them away one at a time I increase and increase the resistance of the magnetic circuit till, when all are gone, the resistance is of air only across the poles of the primary.

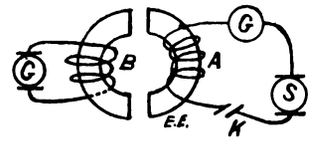

Fig. 6.

1. If now I make the primary circuit, I get a deflection on G_1.
2. Break the circuit; I get an equal and opposite deflection on G_1.
3. Take out all the secondary iron core, and make primary circuit again. We now get a deflection on G_1.

The deflection G_1 No. 1 and G_1 No. 3 are very different, that in No. 1 being the larger.

4. Insert half the core of B, and make primary circuit again. We get another deflection on G_1.

The deflection G_1 in 4 is greater than in 3 and less than in 1.

5. Insert more of the core of B—now making it three-quarters of core—and repeat operation.

Deflection on G_1 is greater than on 4, still less than on 1. In fact, the difference in the deflection of G_1 in experiments 1 and 3 gives us a clue to the value of the iron core in reducing the magnetic resistance.

In both these sets of experiments we can show that the sum of certain arithmetical values of driblets is equal to the arithmetical value not in driblets; but what I want to impress upon you is the fact that although we may arithmetically tot up the same total, the practical result of the two totals is another question.

A thousand or a million boys may shoot peas from pea-shooters at a fortification during the course of 20 years and make no impression, when an 80-ton gun loaded with shell might at one effort blow the whole thing to smithereens.

The best effect to be obtained by the action of lines of force upon a conductor is to loop all the lines of force at one and the same time around the conductor, or to unloop them all at the same time from around the conductor.

This is just what Pixii did not do. He put his lines of force through his coils in driblets, and took them out again in driblets; hence the inefficiency of his machine. It is easy now to see how Pixii might have improved his machine; but it had other weaknesses besides the time it took in magnetising and demagnetising his armature core, only one of which it is necessary to trouble about—viz., that a permanent magnet always gives a weaker field than an electromagnet. If, then, current effects are due to number of lines of force, it is easy to see the larger the number in a given area—that is, the stronger the field—the better is the result.

The Field in Practical Work.—It has been stated that the aim of electrical apparatus is the transformation of energy of another kind into electrical energy, and that the ring apparatus of Faraday was not suited for this purpose. We want to generate a magnetic field in a medium into which we can bring and also take away the conductors upon which the field is to act, or, what comes to the same thing, instead of bringing conductors to the field in which we can take the field to the conductors. The ordinary scholastic view, that the magnetic field of a magnet is illimitable in extent, is incorrect. Practically the area of any particular field is comparatively small, and is absolutely limited. It is as certain as anything well can be that what we represent by lines of force constitute closed curves. There is no such thing in magnetism as an

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unclosed curve Now, magneto-motive force, of whatever magnitude you like to take, is powerless to form these curves, or force lines—or flux curves—through more than a certain resistance; hence the longest curve line of force is that which is formed when the pressure just overcomes the resistance—and there is none after this. For practical purposes, we limit the area of the field as much as possible and obtain the greatest density of lines in that area. For the purposes of calculation, we may take as the unit of magnetic resistance the magnetic resistance between the faces of a cube of air, the length of the side of the cube being one centimetre. In many—I think in most—calculations an inch cube would be better than a centimetre cube, but the former is appropriated by science. I would like to call this unit resistance a *resistant*—the Americans call it an oersted. Englishmen have not yet agreed what to call it; therefore as we can do very well without the name, the symbol R will answer all purposes. Similarly, I might call unit P the *pressant*, and the unit L the *lineant*. The magnetic resistance of iron varies considerably. For purposes of calculation we may take it as 500 times less than that of air. Thus the magnetic resistance between the two opposite faces of a centimetre cube of iron, or an inch cube of iron, is 500 times less than that between the opposite faces of similar cubes of air. If, then (Fig. 1), the core, C, is a continuous ring, say, with an axial length of 12in., its magnetic resistance is that due wholly to the iron. Suppose, further, the sectional area to be a square inch, and that 100,000 lines are generated by the magneto-motive force used. A similar magnetic circuit, if composed of air, would have a resistance 500 times as great, and the lines of force through it would be $\frac{100,000}{500} = 200$. Suppose I cut the core, C, Fig. 7, and have an air-gap, G, of 1in.

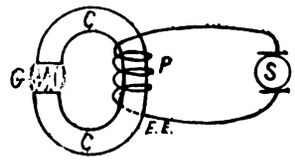

FIG. 7.

length. This air-gap has a resistance of equal to 500in. of iron, so that the total resistance is now equal to 512in. of iron, or $\frac{512}{12} = 42{\cdot}6$ times what it was before. With the same pressure, instead of 100,000 lines, we shall now get $\frac{100,000}{42{\cdot}6} = 2,350$, nearly.

In actual practice the resistance is not increased quite so much as this, because the lines of force spread out and the sectional area of the air-gap field is greater than the sectional area of the iron core, but this increase of area leads to less density of field over the area. The introduction of an air-space into a magnetic circuit is thus seen to be a disadvantage, but we cannot avoid it in the construction of our apparatus.

THE COST OF WORKING POWER STATIONS IN AMERICA.

The adjoined table gives the cost of working 20 different power plants in America for the past six months. The table was prepared by the *Street Railway Review*, and certainly presents an interesting and valuable study, notwithstanding the many unavoidable blanks. Reports 6 and 14 are from plants with mechanical stokers. Among the best reports is No. 19. It shows the best evaporation on the list (it has forced draught and economisers in the stack), and in spite of the high price of fuel comes out with a total cost of power comparing favourably with many plants where fuel is cheaper, and this, too, without excessive fixed charges. The great economy of condensing is in all cases apparent. The most striking differences are in the water evaporated per pound of coal. Even allowing for the differences in coal, there are still great varia-

No. of report	Description of equipment. (* Including fixed charges.	Output in E.H.P. hours per day.	Hours railway is operated per day.	Fuel consumed per E.H.P. hour (pounds).	Coal fuel per E.H.P. hour (pence)	Water used per E.H.P. hour (pounds).	Water evaporated per pound of coal (pounds).	Cost station labour per E.H.P. hour (pence).	Interest on cost of station per day. £ s. d.	Interest on cost of station per E.H.P. hour (pence).	Cost oil and waste per E.H.P. hour (pence).	Total cost power per E.H.P. hour (pence)	Total cost power per motorcar mile (pence).	Coal fuel per ton of 2,000lb. at power-house. s. d.	Kind of fuel.
1	Water-tube boil. Comp. cond. marine eng. Direct belt	15,267	21	6·14	·158	22	3·08	·083	3 12 6	·056	·041	·379*	—	4 3	Ohio lump and slack.
2	Water-tube boil. Comp. high-speed eng. Direct belt	2,508	24	4·30	·322	28	6·60	·070	— — —	—	·249	·421	—	12 4	Pittsburg lump.
3	Hor. ret. flue boil. Comp. cond. h.-s. eng. Direct belt	2,038	18	4·90	·311	—	—	·183	— — —	—	—	·502	—	10 7	Soft lump.
4	Hor. ret. flue boil. Simple Corliss eng. Line shaft	3,150	18	8·00	·400	35	4·37	·150	— — —	—	—	—	·441	8 4	Soft screenings.
5	Lancashire boil. Comp. cond. Corliss eng. Direct belt	46,000	24	2·78	·154	—	—	—	22 18 4	—	—	·235	·470	9 3	Soft screenings.
6	Hor. ret. flue boil. Comp. cond. m. s. eng. Direct belt	4,500	24	3·00	·059	20	6 66	·100	1 9 2	·077	—	·167	·470	3 3½	Soft screenings.
7	Hor. ret. flue boil. Simple Corliss eng. Direct connected	14,469	24	5·00	—	30·19	6·03	—	— — —	—	—	·250	·760	—	Soft lump.
8	Hor. ret. flue boil. Simple cond. Corliss eng. Direct belt	2,188	17·5	5·00	·125	23	4·60	·250	— — —	—	—	·381	—	4 2	Soft screenings.
9	Hor. ret. flue boil. Simple Corliss eng. Direct belt	1,323	18	3·90	·257	—	—	·300	— — —	—	—	·572	·750	11 0	Soft run of mine.
10	Hor. ret. flue boil. Com. cond. Corliss. Line shaft	2,560	16	3·06	·183	20·6	6·75	—	— — —	—	—	—	—	10 0	Soft screenings.
11	Hor. ret. flue boil. Comp. cond. Corliss. Direct connected	7,700	20	2·62	·170	—	—	—	— — —	—	—	·250	·430	10 10	Soft pea.
12	Water-tube boil. Simple cond. Corliss. Direct belt	7,100	24	·3 gallon	·200	27	9 pr. g.	·100	4 5 10	·140	—	·310	·825	0 0¾	Per gallon oil fuel.
13	Water-tube boil. Comp. cond. Corliss. Direct connected	3,444	20·5	3·66	·219	—	—	·214	3 15 0	·261	—	·473	·602	10 0	Soft lump.
14	Hor. ret. flue boil. Simple h.-s. engine. Direct belt	48,000	24	3·35	·101	29·8	7·74	·051	— — —	—	—	·167	—	4 4½	Soft lump.
15	Water-tube boil. Triple exp. cond. Corliss. Line shaft	14,250	19	·24 gallon	·288	24	10 pr. g.	·070	9 7 6	·157	·015	·540	1·430*	0 1¼	Per gallon oil.
16	Water-tube boil. Comp. h.-s. eng. Direct connected	5,000	—	—	—	23	9·00	—	— — —	—	—	—	—	—	—
17	Hor. ret. flue boil. Simple h.-s. eng. Direct belt	720	18	6·00	·262	—	—	·250	— — —	—	·065	·592	—	7 3½	Soft run of mine.
18	Water-tube boil. Cond. comp. and simple eng. Direct belt	21,862	20	4·39	·230	35·56	8·33	·146	— — —	—	—	·391	·633	8 9	Soft lump.
19	Water-tube boil. Comp. cond. Corliss eng. Direct connected	5,021	19·2	2·14	·214	21·4	10·00	·174	3 17 1·	·184	·032	·406	1·566	16 8	Soft lump.
20	Hor. and upt. flue. boil Comp. cond. Corliss eng. Direct connected	8,713	19	3·00	·166	—	—	·061	4 5 7	·117	·004	·379*	·661	6 8	Soft nut and slack.

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tions, part of which, no doubt, can be accounted for by wet steam and errors in water-meters. Where the water consumption of the engine is low, however, there is no probability of wet steam. Allowing for all errors, it is not too much to say that there is more chance for improvement in methods of burning coal than in any other step in the transformation of the energy between coal pile and line. Considering the great gain in economy made by condensing engines, it is strange that more attention has not been given in the past to means for providing water for condensing where the station is not situated on a natural body of water. This saving will pay interest on a good-sized investment, and make it worth while to investigate very closely the methods which have been used for cooling and using over and over again the same condensing water.

THE ELECTRIC LIGHTING OF THE HOTEL CECIL.

Through the courtesy of the management, we are enabled to give some particulars of the electric lighting of the huge building which has been for some years in the process of erection on the sites of Salisbury, and Cecil streets. When everything is complete the Hôtel Cecil will contain more than 15,000 incandescent lamps, most of which are 16 c.p. The aggregate length of wiring is reckoned by miles, so that, although a private installation, the work is one which, so far as magnitude is concerned, comes within the dimensions of undertakings for public supply. The hotel is to be opened on May 6, and on visiting it this week all departments were working at high pressure to get everything ready and complete by that date. Much necessarily remains to be done at the last moment, and there is very little time to spare, so that it becomes an act of the barest justice to begin with an acknowledgment of the courtesy of Mr. W. R. Beckton, the resident engineer, in trenching upon his valuable time to give us facilities for obtaining information as to the work that has been done. The Hôtel Cecil consists at present of three blocks—the southern, western, and eastern—of which the eastern is considerably the largest. These are arranged round a central courtyard. A fourth block—the north—facing the Strand, will complete the quadrangle, but the area of this was not included in the original site, and parliamentary powers had to be obtained for its acquisition. Though the matter is practically settled, the final formalities are not even yet complete. The grand entrance and restaurant, which are to face a widened and improved Strand, therefore exist at present only on paper, and the area is at present occupied by ordinary shops, which entirely mask the grand proportions of the buildings.

Leaving the history of the undertaking, it will be sufficient to say that the property is now owned by a limited company, of which Viscount Hardinge is the chairman. The site of the building is a somewhat severe slope from the Strand to the riverside, and consequently on turning into what seems an entrance roadway and a long courtyard on a level with the Strand, the visitor has really a very great deal more building work beneath his feet than he would be likely to imagine. It is naturally in this part of the hotel that space has been found for the boilers and machinery of the generating plant. As a matter of fact, these are placed in the arches which carry the basement floor of the western block. It is probable that it was not originally intended to provide a generating plant at all, but to take current from the Charing Cross and Strand Company, whose station is in the immediate neighbourhood. In reference, therefore, to the type of the machinery installed, it must be remembered that the space in which it was to go had to be considered as well as the output that would be required from it. This,

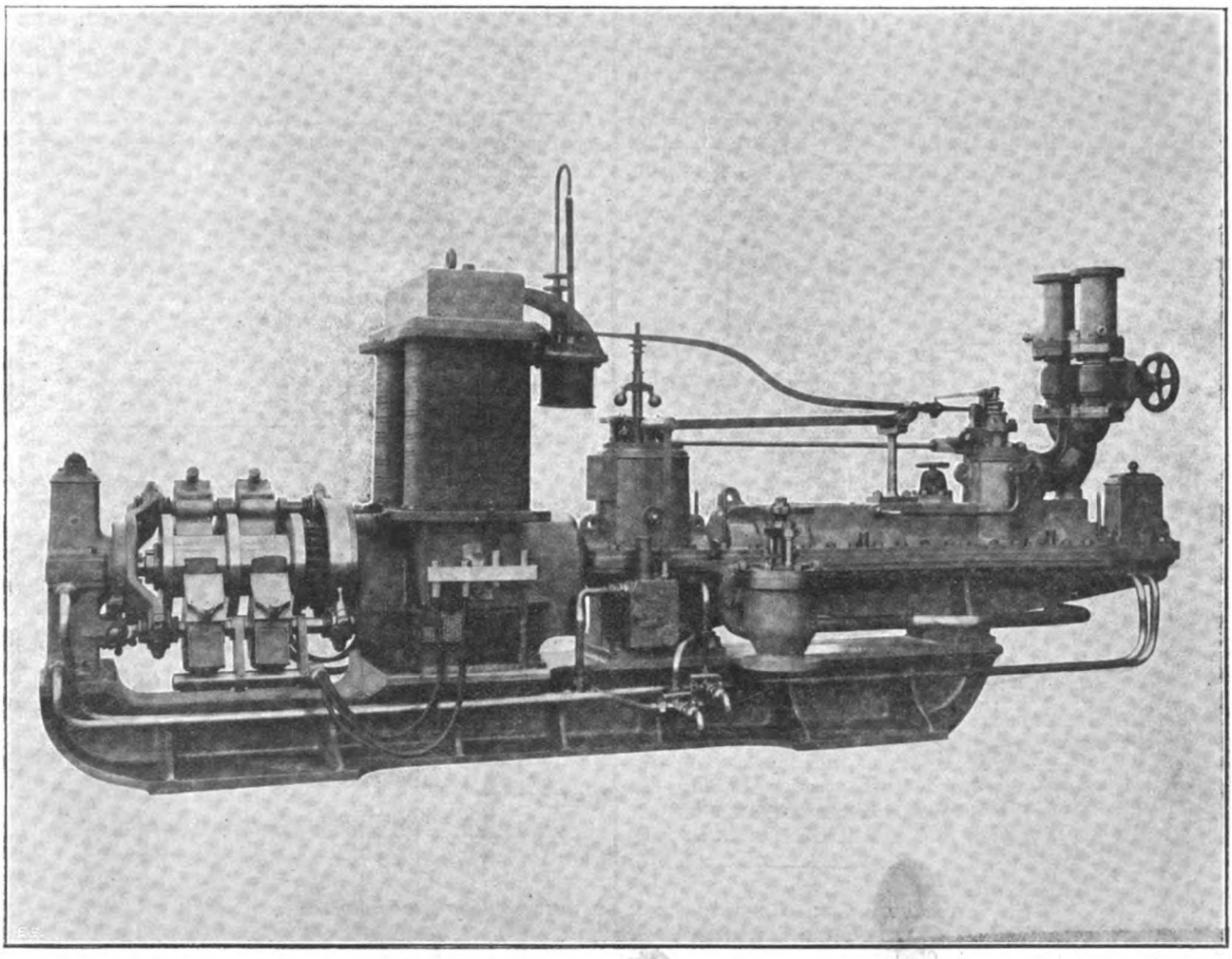

FIG. 1.—View of Parson's 75-K.W. Steam Turbine and Dynamo.

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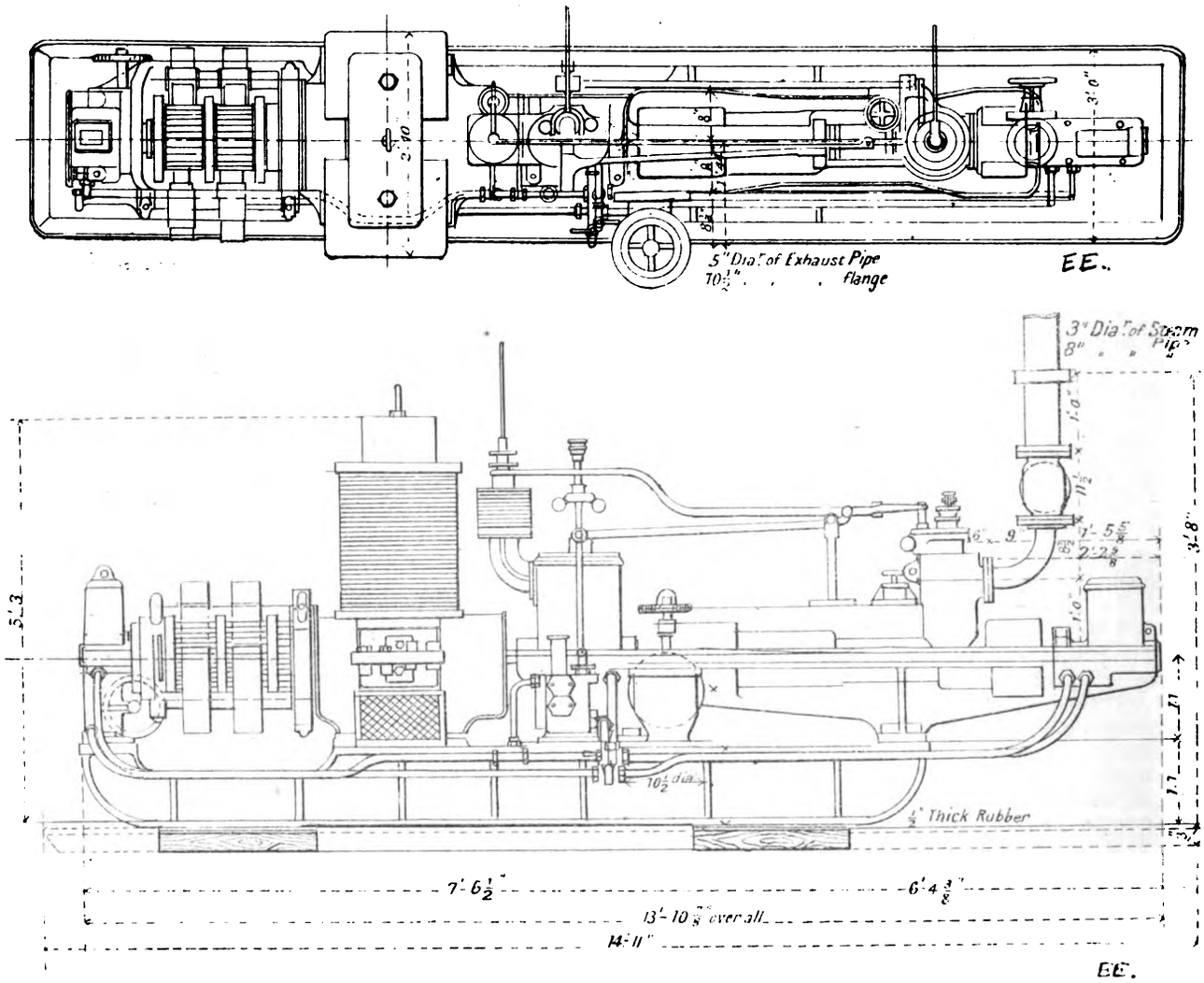
the generating plant, has been put down to the specification of Mr. Robert Hammond as consulting engineer for the generating plant, switchboards, etc.

Starting with the boilers, there are to be five of these, made by Messrs. Davey, Paxman, and Co., of Colchester. They are of the "Economic" type, and are capable of evaporating 5,000lb. of water per hour at a working pressure of 140lb. per square inch, using feed water at a temperature of 60deg. F. Four of these are 14ft. long by 7ft. 6in. in diameter, but the fifth is larger, being 14ft. 6in. by 8ft. in diameter. At present, however, only three, including the larger one, are in position. Hopkinson's fittings and valves are used throughout. There are four Brown's patent Berryman feed heaters, and the boilers are fed through these by electrically-driven Hayward Tyler plunger pumps supplied by the Electric Construction Company. Injectors are provided so as to give an alternative feed in case of breakdown. The steam-pipes are supplied trically governed, so that when the dynamo is working alone regulate as though it were compound wound. The full details can be seen from the illustrations, which also show the connections for the duplicate steam-pipes. The foundations required for these turbines can be exceedingly light, as the absence of reciprocating parts prevents all tendency to vibration. Hence the set is especially valuable for crowded parts of large towns, where space is valuable, and where stray vibrations are heavily taxed as nuisances.

It will be seen that the maximum output is 300 kilowatts, but there are extensions contemplated. On a basis of 15,000 16-c.p. lamps it would look as though these would be necessary, though it must be remembered that the Charing Cross Company is always at hand as an additional source of supply.

With regard to the engine-room, it may be added that there is an overhead traveller by Messrs. Arnold Goodwin and Son, of Southwark. Ventilation will be provided for by



FIGS. 2 AND 3.—Plan and Elevation of Parson's 75-K.W. Steam Turbine and Dynamo.

by Messrs. John Spencer, of the Globe Tube Works, Wednesbury, and are entirely in duplicate, so that one set can be cut off for repairs.

It has been mentioned before that, so far as room is concerned, the designer of the plant had anything but a free hand, and when the space is seen into which the generating machinery has had to be put, it is obvious from the first that anything in the nature of engines with rope-driven dynamos was out of the question. There was simply no room for them. The only possible choice was between more or less compact forms of machine, with the proviso the more compact the better. As the result, steam-turbines have been adopted, and the generators consist of four turbo-dynamos, made by C. H. Parsons and Co., of Newcastle-on-Tyne. Each of these has a capacity of 75 kilowatts—*i.e.*, 710 amperes at 105 volts. They run at a speed of about 4,000 revolutions per minute. Three sets are shown in Figs. 1, 2, and 3. The machines are used in parallel and are shunt wound, but elec-

Blackman fans, and there are also a number of these in the offices, laundry, and corridors. The engine-room and boiler-house adjoin, but one regrettable result of the building having been completed before any of the machinery was designed is that the boiler-house floor is somewhat above the level of the engine-house. This, however, was inevitable. Another difficulty that occurred was to devise a convenient way of getting in the coal supply. Coaling is always a dirty and messy operation, and it is obvious that it should be done as much as possible out of sight and out of the way of the visitors of the hotel. The original plan by no means fulfilled these requirements, but Mr. Beckton has been able to work out one that will meet the difficulty. The principle is that the coaling will be done from below instead of from above, the coal coming in on carts by the lower roadway to a point underneath the main quadrangle and about 12ft. or 16ft. below the coal-store. They will be then lifted by a two-ton lift to the store, which is 6ft. above the boiler-level. The day's supply will

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be shot from the store through a shoot into the bunker-room, which holds about 25 tons, and thence distributed by barrow as required. The ashes will be got rid of through a door into Ivybridge-lane, and thence by the lower roadway.

Reference has been made before to the fact that the Charing Cross Company is available for an alternative supply of current. A special main has been laid from that company's generating station into the building, and there are already a considerable quantity of lamps running whose current comes from this source. Provision has been made on the switchboard for using either the company's current or that generated on the premises. So far as the latter is concerned, the current is taken from the generators to massive copper 'bus bars at the back of the board, and thence distributed to the various panels. The board stands directly opposite the machines. It has a framework of wrought iron with slate panels. As may be supposed, the changing-over switch is a prominent object in the centre of the board. It is a massive affair, and it is confidently expected that it will effect the change over so instantaneously that the resultant flicker in the lights will not be perceived. There are ammeters for each dynamo and circuit and two voltmeters over the board. The hotel installation is on the two-wire system, while the Charing Cross Company's is a three-wire one—all three wires being brought into the building. The company's wires therefore do not go on to the 'bus bars, but direct to the two main circuits into which the wiring is divided, so that at any rate an approximate balance may be obtained.

The general principle of the wiring is to take two circuits into each block of buildings, and a separate circuit for the arcs. It is intended at present to use the company's supply entirely during periods of light load, but a contract has been concluded by which heavy currents will be obtainable after a sufficient notice; but as the machinery consists of four units, it is hardly likely that two of the dynamos would be out of order at the same time, and hence there seems little likelihood of a heavy supply being required from the company.

A test-room is being equipped in connection with the engine-room.

So far as distribution is concerned, each of the four blocks will be, as far as possible, on an independent system of circuits, with a distributing board in each part of the building. Throughout the building the smaller switches are of the tumbler type, and those on the switchboard have spring contacts. It should be said that, in addition to the incandescent lamps, there are six arc lamps in the quadrangle and porches, and six more on the river front. These are 12-ampere lamps of the Brockie-Pell type, and besides these there is the illuminated fountain in the quadrangle, which will be described later on. The consulting engineer for the wiring of the hotel is Mr. Morgan Williams.

It is stated that in one way or another the cable for wiring purposes runs up to a total length of over 125 miles. In the large banqueting hall the lamps are grouped on massive electroliers, and this principle is in the main followed throughout what is called the Empire floor as well as in the ladies' drawing-room. The electroliers are characteristic of the period and style adopted in the various rooms.

On the Indian floor, however, where an Oriental style of decoration has been adopted and carried out with considerable boldness and freedom, an opportunity was afforded for a new departure. Throughout this floor the lamps are arranged in single lights. A large number of pendants are spaced at equal intervals over the ceilings and along the corridors, so as to give an equally diffused light almost entirely free from shadows. Cut-glass shades are here used with excellent effect. The design of many of these lamps appears to be copied from that of the hanging lamps that are a prominent feature in Eastern mosques. These are decidedly graceful in appearance and eminently appropriate to the decorations. The brilliancy of the illumination will be strikingly un-Oriental.

The same principle of equal distribution, but by carefully shaded lamps, has been applied to the billiard-room, which is on the Indian floor. In other parts of the hotel a compromise between the system of grouped or distributed lamps is adopted according to the circumstances of the case.

The arc lamps have already been mentioned. With these there will be an abundance of light in the quadrangle and under the large glass *porte-cochère*. An additional feature will be an electrically-illuminated fountain in the centre of the court. Underneath the quadrangle there is a 20ft. roadway. The apparatus for reflecting the light into the fountain is carried on a gantrey running across this. Before leaving the subject of the electrical machinery, it may be mentioned that all the laundry machinery will be electrically driven. "Castle" motors are used for this purpose. The contractors for this part of the work are Messrs. Manlove, Alliott, and Co., of Nottingham.

The staff of the hotel is to consist of about 700 persons and the distances are so great that one of the first question that strikes a visitor is, how is communication to be maintained with the various departments and how long will it take to get anything that is wanted. A large number of lifts provide for the actual conveyance of person or material, while the forwarding of orders will be greatly facilitated by a very complete system of telephones. There is a telephone to every room, and there is to be a sub-exchange board on every floor, so that the visitor can speak to the service room or through to the manager's office. Again, each sub-exchange is connected by a trunk line to a principal exchange situated in the sub-basement of the southern block. It will therefore be possible, practically, to speak to any part of the buildings, the system being similar to a public exchange.

INSTITUTION OF ELECTRICAL ENGINEERS, April 30.

At last night's meeting of the Institution the following paper was read:

ON RAILWAY TELEGRAPHS, WITH SPECIAL REFERENCE TO RECENT IMPROVEMENTS.

BY W. LANGDON, MEMBER.

The subject with which this paper deals is one which has not, for some time, claimed the consideration of members of this Institution. The progress which has attended the application of electricity to railway telegraph work is in no way comparable with that which has in recent years marked its progress in relation to lighting and power. Such advances as have been achieved are to be found more in minor details than in any radical change. Probably the most noticeable fact presides in the greater freedom from serious breaksdown which we now enjoy, and in the growth of the telegraph service—a striking testimony of its increasing utility. Competition is a stern and exacting master. The train service of to-day must not only be well equipped, but it must work well to time. That which yesterday was thought ample, is to-day found wanting. Each day ushers in fresh demands, greater elaboration, greater exactitude! How useful a factor the telegraph becomes in enabling this to be accomplished is probably known only to those in whose hands rests the responsibility of that which has to be done.

In the year 1880 the late Mr. Edward Graves, one of our past-presidents, and for many years our honorary treasurer, brought under the notice of members some extremely interesting statistics in relation to the progress of telegraphy, in which he produced a comparison between the mileage of wire and the number of instruments in use on the various railways in Great Britain in 1869 and 1879.

By the courtesy of the controlling officers of practically the entire railway service of the country—to whom my acknowledgments are gratefully tendered—I am, with the exception of the data of some two or three of the minor companies, enabled to bring forward this information another decade and a half. Accepting Mr. Graves's figures as a basis, and making allowance for the expansion of those systems the returns for which are not to hand, we get the following approximate results:

		Miles.	Increase.
Mileage of wire employed for railway purposes.	1869	27,204	—
	1879	62,099	34,895
	1889	84,423	22 324
	1894	99 296	14,873
		Instruments.	**Increase.**
Number of instruments employed for railway purposes.	1869	10,121	—
	1879	46,847	36,726
	1889	100,590	53,743
	1894	130,339	29,749

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It will be understood that these figures are not put forward as absolutely correct. They may, however, be accepted as fairly representative, and as a very near index of the progress and increasing influence of the telegraph service.

Prior to 1870 block signalling was but sparsely employed. During the decade 1869-79 it met with general adoption, which accounts for the large increase in both instruments and wire during that period. The increase during the half decade 1894 is, in relation to that of the preceding decade, remarkable, as indicating that the expansion is still in active operation. These figures tell their own tale of utility in the management and regulation of railway traffic, while from the mileage of wire maintained by the railways for the Postmaster-General, amounting approximately to some 67,000 miles, it may be reasonably inferred that the railways are in no small degree contributing to the convenience of that branch of the public who from day to day seek the service of the Post Office wires. Let us pause but a moment to consider how the present enormous traffic of our railways, or the mass of matter which daily passes over the various telegraph services of the country, could possibly be dealt with without these aids, or how the conditions of commercial life would be effected by their cessation, and we at once become sensible of their value.

Individually, possibly few railways afford a more forcible illustration of the rapid growth of a railway telegraph service than that to which the author is attached. In 1878 the total mileage of wire on the line amounted to 9,816 miles, and the number of instruments to 7,702. The mileage of wire to-day exceeds 22,000, and the number of instruments closely approximates to 19,000. This large expansion is naturally calling for increasing accommodation for wires, and, in the interest of economy, for a careful study of the cost in both construction and maintenance.

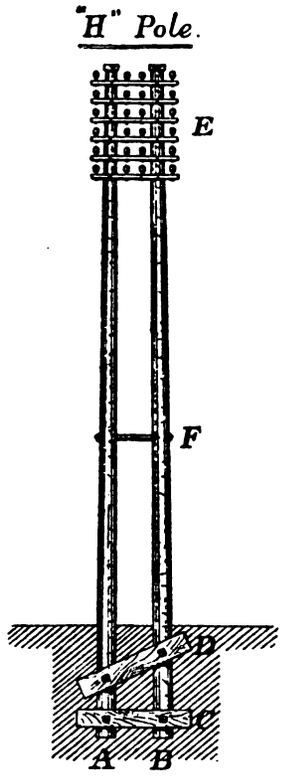

Fig: 1.

Poles.—One of the chief factors to which we are indebted for the greater stability of our lines of telegraph at the present time is the employment of poles which have been charged to a certain extent with creosote. In the session of 1873-74 a paper, "On the Preservation of Telegraph Poles," was read before this Institution, then the Society of Telegraph Engineers, in which the various processes for the preservation of timber were discussed. Of the several methods there referred to, the creosoting process may be regarded as the sole survivor. Creosoted poles are now almost universally employed. Their life, or the period they may remain in position without deterioration from decay, is still, to all intents and purposes, undetermined. Given a properly-seasoned pole, fairly dry when placed under the process, its life may reasonably be relied upon to cover the period the pole is required to stand before additions or alterations call for its replacement. It is neither necessary nor desirable that the timber of telegraph poles should be completely charged with creosote. The quantity of creosote impressed into telegraph poles is usually 8lb. to the cube foot of timber; and this quantity, where the wood is properly seasoned and well dried, will be found to have penetrated to the core or heart-wood of the pole. It will thus form a complete protective shell, impervious to moisture; and in this lies the main advantage of the application. Timber which is thoroughly impregnated or saturated with creosote becomes, as soon as the oil is dissipated, devoid of much of its elasticity, and is then more easily broken than if the heart-wood of the timber is allowed to remain uncreosoted. There are points where creosoted poles are objectionable—such, for instance, as station platforms. Here, whereas in former years Memel timber was usually employed, it is preferable to use pitch-pine. Pitch-pine is more durable than Memel. It is more resinous, and thus more antagonistic to the reception of moisture; and it is the moisture which, traversing the fibre of that portion of the timber in the soil, under the influence of the warmer atmosphere above the ground line, disintegrates it at or about the ground level, and so destroys it. The number of wires which have now to be accommodated, in many instances, call, not merely for stout poles, but for structures such as H poles. These structures (Fig. 1) consist of two poles, A B, braced together at the foot by a slab of wood, C, as nearly as possible at right angles to the poles, and a further slab, D, some 4ft. from the butt end of the poles, arranged diagonally; the arms, E, at the top of the poles act as the tie-pieces at that end of the structure. These are sometimes, especially in high poles, supplemented by a stiff iron rod, F, passing through the two poles, at right angles to them, or by rods crossing one another diagonally, tied together in the centre. The practice has been to allow the two poles forming the basis of this structure to have a slight spread at their butt ends—*i.e.*, taking a centre line down the poles, the distance between these lines at the top of the poles being some 12in. less than that between the centre lines at their butt ends. When poles become crowded with wires, this, with respect to the lower arms, detracts from the regularity of the insulators and wires. It is better that the poles should be equidistant throughout. You have then merely to provide for the increasing thickness of the timber in order to ensure perfect regularity in the position of the wires from top to bottom. The Midland Railway having recently been called upon to construct for the Postmaster-General a section of an important trunk line to Scotland, it has been necessary to convert an existing line of single poles into an H line. To construct these H poles, braced together at the foot, as shown in Fig. 1, would have meant the replacement of the entire line—a most expensive operation. Under these circumstances, the existing line of poles has been allowed to stand. At the proper distance a pole, B (Fig. 2), to match the standing pole, A, has been placed in position, care being taken to cut off the butt end so as to ensure a flat basis. It has then been allowed to stand some days, so as to become well settled in its position, after which slots for the arms are cut to correspond with those on the original pole. The short arms are then one by one removed from the latter and replaced by arms 56in. long, which are bolted to the two poles. Where the old line of poles has been systematically constructed with the arms, say, 12in. apart, centre to centre, the appearance of

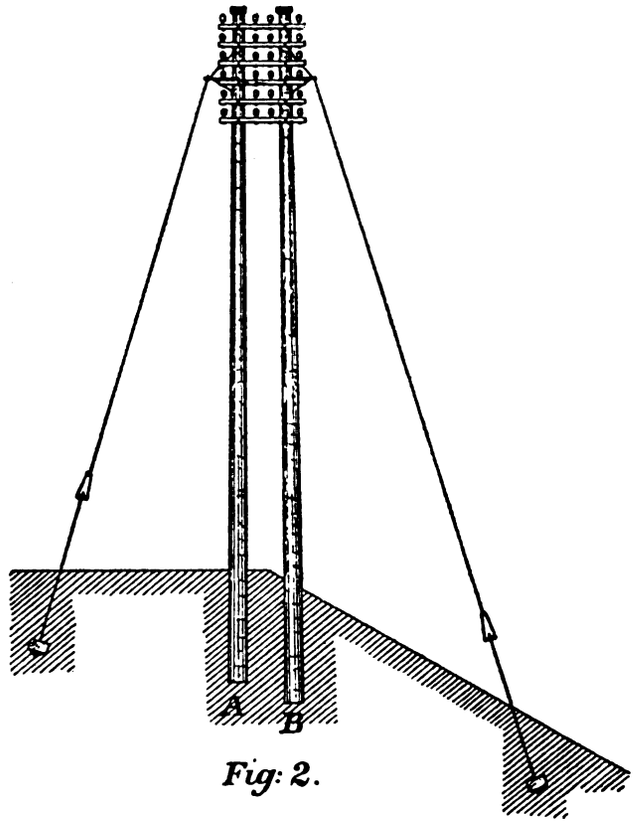

Fig: 2.

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such a combination is in every way agreeable to the eye. It will be evident that without the diagonal tie-piece the poles might, under stress of wind, work themselves out of position. This has to be met by staying them in the same manner as a single line. Where, from exceptional causes, the poles cannot be stayed, the diagonal tie-piece should be employed. Photographs of sections of the line of poles thus treated are on the table. H poles are destined to be of great service. There is no reason why the number of wires should be limited to four on an arm. The 56in. arm may be replaced by a 72in. arm, accommodating six wires, thereby increasing the capacity of the poles one-third. We may even venture beyond this where the need for it exists, employing either iron arms, or wooden arms of larger scantling, in order to meet the weight of the wires standing on the outer side of the poles. The structure is one which, if well stayed, will withstand gales far better than single poles with half the number of wires, arranged two on an arm. Moreover, it will be observed that H poles, with six wires on an arm, lend themselves to telephone requirements. With the wires arranged two outside each pole and two between the poles, three groups or squares may be formed by each pair of arms, each wire of each "square" or "group" being maintained 1ft. apart. A photograph of poles so armed is on the table. Telegraph poles seldom commend themselves to the observer as an æsthetical subject; but uniformity in construction, with the poles well in line, or regularly following the contour of the road, evenly graduated for height, and uniformly armed and wired, with perhaps an ornamental top in exceptional places, will do much towards removing those objections which are not unfrequently raised against their presence.

Arms.—In the trimming of poles the most novel feature is the introduction of iron arms. Forty-four-inch tubular iron arms, specimens of which are before the meeting, have been employed for some 100 miles of the trunk telephone line recently erected by the Midland for the Postmaster-General. Some years prior to this shorter arms—tubular and rectangular, for carrying two wires—were experimentally employed by the author. No inconvenience whatever has so far attended their employment. The longer (44in.) arm (Fig. 3) is composed of 1¾in. galvanised iron tubing, A, ⅛in. thick, strengthened by a piece of larger gauge tubing, B, of same thickness, 2in. in diameter, carried over the centre portion of the 1¾in. tubing. The two tubes thus combined are practically homogeneous and very strong. The employment of these arms admits of a slight reduction in the length of the insulator bolt, which may, with advantage, have the shoulder of the bolt, as

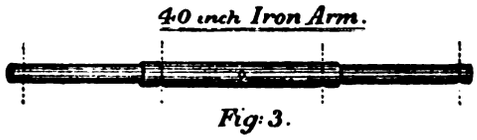

Fig. 3.

also the washer, hollowed out to fit the arm. Thus arranged, there is no possibility of the insulator twisting round. These arms should be very durable, and it is worthy of remark that they do not require so much of the pole cut away as is necessary for the wooden arm. The earth wiring of wooden arms has, the author believes, in some quarters been abandoned. That course has not been pursued on the Midland. Earth wiring, as illustrated by the sample placed upon the table, is still followed. With iron arms the need for earth wiring disappears. It is merely necessary to lay the main earth wire securely under the washer of the arm bolt. Clearly, where iron arms are employed, failure in insulation such as that produced by a broken or cracked insulator will readily make itself known. To what extent this will operate with respect to the iron arms experience must show. In a trunk telephone line discrepancies in the insulation of the four wires forming a square would appear to be undesirable factors. Whether such failure may be more readily traced with iron than with wooden arms has yet to be proved. The iron arms ought, where "earth" is the cause of failure, to give a more defined fault, and thus lead to its more ready removal. Iron arms and brackets, as well as iron poles, have in various forms been in use for years, especially for foreign lines; and probably no member of the Institution has a more intimate knowledge of their value than our past-president, Mr. Alexander Siemens. In slotting round poles for these iron arms it was at first thought that a V-shaped cut would readily lend itself to the reception of the arm; but experience has shown that it is better to slightly slot the pole, as though for a rectangular arm, and gouge out the base of the slot. The pole being round, the V-shaped cut fails to retain the arm in that rectangular position, in relation to the pole, which is necessary to give the line that trim and uniform appearance so acceptable to a good workman. In the employment of wooden arms there is nothing of a novel character to record. They are to-day very much as they have been during the last 20 years. It may not, however, be inopportune to raise the question whether English oak is the only timber from which they should be made. Doubtless English oak is more durable and stronger than other timber; but it is a question whether foreign oak—say Stettin—if cut under the conditions applicable to English oak—viz., well seasoned, free from knots, and free from sap—is not sufficiently durable and strong for the purpose. Arms cut from this description of timber have been in use on the Midland system for many years, and nothing has transpired to create a want of confidence in its suitability for such work. Another point worth considering is that of painting the arms. Paint, if applied when the timber is properly seasoned and dry, is, no doubt, beneficial; but paint applied to wood which does not possess these qualifications produces dry rot, and is, consequently, absolutely injurious to the timber, and dangerous to workmen when on the poles. Where the arms can be stacked by the user until thoroughly seasoned, they may with advantage be painted.

(To be continued.)

The following were the candidates balloted for:

Associates.—Fred A. Donnison, 29, Aberdeen Park, Highbury; Leo Arthur Hards, 57, Grosvenor-road, S.W.; James Leggat Kilpatrick, 23, Delafield-road, Charlton, Kent; F. A. B. Lord, 24, Billiter-street, London, E.C.; Ernest Wilmot Rees, Bron Siriol, Carnarvon; Louis Schramm, care of Electrical and General Engineering Company, 86, Leadenhall-street, E.C.; William Wyld, Corporation Electricity Works, Blackpool.

Student.—Edward A. Short, Saham-Toney, Walton, Norfolk.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

May 1, 8 p.m.—At the Institution, Great George-street, Westminster. Students' meeting. "Swing Bridge over the River Nene at Sutton Bridge," by Edward S. McDonald.

May 5, 8 p.m.—Ordinary meeting. "American and British Methods of Manufacturing Steel-Plate," by J. Head, and "Four American Rolling Mills," by S. T. Willmer.

May 7, 8 p m.—Forrest lecture. "Physical Experiment in Relation to Engineering," by Dr. A. B. W. Kennedy, F.R.S.

Institution of Electrical Engineers.

May 9.—Students' visit to the London Electric Supply Corporation's station at Stowage Wharf, Deptford. Train leaves Charing Cross at 10.20.

Society of Arts.

May 4, 8 p.m.—At John-street, Adelphi. Cantor lecture. "Applied Electro-Chemistry." By James Swinburne. (The second of four lectures.)

May 5, 8 p.m.—"Australia's Prospects in British Markets." By James F. Dowling.

May 6, 8 p.m.—"High Explosives and Smokeless Powders." By Hudson Maxim.

Iron and Steel Institute.

May 7 and 8, 10.30 a.m.—At the Institute of Civil Engineers, Great George-street. Meeting. (A list of papers to be taken is given in our "Notes").

Institution of Junior Engineers.

May 8, 8 p.m.—At the Westminster Palace Hotel. "Notes on Belgian Electrical Engineering Practice," by A. Austruther-Thomson and G. C. Allingham.

Chemical Society.

May 7, 8 p.m.—At Burlington House, Piccadilly. Ordinary meeting.

Royal Institution of Great Britain.

May 1, 5 p.m.—Annual Meeting; 9 p.m., "Chronographs and their Applications to Gun Ballistics," by Colonel H. Watkin.

May 4, 5 p.m.—Monthly meeting.

May 5, 3 p.m.—"Ripples in Air and on Water." By Prof. C. V. Boys.

May 7.—"Metal Working in Japan." By W. Gowland.

May 8, 9 p.m.—"Electric Shadows and Luminescence." By Prof. S. P. Thompson.

Institution of Mechanical Engineers.

May 1, 7.30.—At the Institution of Civil Engineers. Paper on "Steel Steam-Pipes and Fittings, and Benardos Arc Welding in connection therewith." By S. MacCarthy. "Research Committee on the Value of Steam-Jackets: Experiments on Locomotive Engine." By Prof. T. H. Beare and Bryan Donkin.

Society of Engineers.

May 4. 7 30 p.m.—At the Royal United Service Institution, Whitehall. "Hydraulic Rotative Engines," by A. Rigg.

Lambeth.—The electric lighting question, which for weeks past has been under consideration by the Lambeth Vestry, was settled last evening, when, by a majority of 44 to 15, the Vestry decided to hand over the electric lighting order to Mr. C. W. Sax.

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GASEOUS CRITICS.

In our last issue we commented upon some of the criticisms that the gas engineers had been making about electrical work, and pointed out the unfairness of some of their remarks. We have never hesitated in stating that for lighting, and even for heating purposes, gas and electricity are keen competitors. That electricity will win the day we have no shadow of a doubt, but, as has often been pointed out in these columns, the recent improvements made in the use of gas renders the competition keener and the result longer deferred. Some of the adverse comments have been directed against the return obtained by municipalities which have embarked in electric lighting work. There is nothing more misleading in this world than figures — except facts. Both facts and figures may be absolutely correct, yet utterly misleading. What are the facts about lighting? If we state them wrongly, we are open to correction; but our aim is to arrive at the truth, and not to give half-truths in order to mislead. In Great Britain, most of the towns are, and have been for years, lighted by means of gas. So far as the authorities are concerned, they have to pay for the public supply, and have nothing to do with the private supply. Nothing is more certain than the public supply being less remunerative than the private supply, but as a rule the one sooner or later involves the other. A municipal authority taking up the work of electrical supply can control that portion which is less remunerative and cannot control the other. It has then to commence with a supply which is known to be often produced almost, if not quite, at a loss, and to wait events for the supply of that which pays well. Take this fact into consideration in any discussion of municipal electrical supply, and the wonder is, not that huge dividends are unearned, but that working expenses are paid within a year or two of the start. Private houses already lighted by other means are not going to generally take supply from the mains. Here and there one will be connected, but the demand must necessarily be somewhat slow. Still, with all the difficulties to overcome, with the keenest competition to fight, it is remarkable how short a time passes before all expenses are paid. Compared with central stations equipped to supply a whole town, with no other illuminant competing, the present central stations are small and uneconomical, yet these can be made successful. Let us examine a case where an intelligent engineer has guided his corporation—not a large installation, but one of moderate dimensions—namely, that of Hanley. Mr. Lobley is one of the most competent of municipal engineers, and under his supervision Hanley has expended to the end of 1895 in electrical work £32,362. Of this £10,717 was expended during that year, so could not be very productive. The result of the first year's complete working was to sell 180,469 units, produced at a cost of 2·8d. per unit and sold at 4·58d. per unit, bringing in a revenue of £3,444 and a profit before allowing depreciation of £1,443. How the supply of public lighting gradually leads to the supply of private lighting may well be seen

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from the accounts of the City of London Company. At the end of 1892 the number of customers was 242, increasing in succeeding years to 1,080, 2,740, 4,230 respectively; the net revenue corresponding to these years going from £500, estimated for 1892, to £16,940, £34,865, and in 1895 to £59,100. Just attempt to imagine what the result in either of these cases will be when the lighting of private houses in each district becomes general. Of course the price per unit sold will be lowered. In the case of the corporation, that follows a big return as a matter of course. Though, as we contend, it is unfair to give facts and figures relating to many installations without explanations, when the latter are forthcoming, instead of damaging electrical work, they tend to encourage it. We cannot pretend to be uninterested in this matter, but our interest will not prevent an earnest attempt to deal with the question so as to bring out the truth. Electrical work must progress because of its intrinsic merit, not by means of false witnesses, and, on the other hand, it will not be damaged by the suppression of important information.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

A PLEA FOR COMPOUND ARITHMETIC.

SIR,—The number 380,160 is, of course, that of inches in six miles. I know not how I came to copy it as one mile, but was meaning to contrast it with seven miles. In fact, however, seven furlongs make a better unit than a mile. The latter, 63,360in., has but 94 divisors, while seven furlongs, or 55,440in., is cumetric, and has 118. The number of divisors is found by deducting two from the product of the indices of all the factors, each augmented by one. Thus,

$$63{,}360 = 2^5 \cdot 3^3 \cdot 5 \cdot 11\text{;} \quad \text{whence } 8 \cdot 3 \cdot 22 = 96.$$

But

$$55{,}440 = 2^4 \cdot 3^2 \cdot 5 \cdot 7 \cdot 11\text{;} \quad \text{whence } 5 \cdot 3 \cdot 2 \cdot 2 \cdot 2 = 120.$$

Yours, etc., E. L. GARBETT.

25, Claremont-square, N., April 24, 1896.

OBITUARY.

The death is announced of Mr. H. J. Vose, M.I.C.E., of Cardiff, superintending engineer of the Post Office telegraphs for the South Wales district. Mr. Vose passed practically the whole of his official career in the engineering department of the telegraphs. He joined the staff of the late Mr. Edward Graves in 1871. Mr. Graves was then divisional engineer of the old north-western district, with headquarters at Birmingham. On Mr. Grave's promotion to the position of engineer-in-chief in 1878, Mr. Vose followed him to London, and acted as his confidential assistant, with a short break, until his death in November, 1892. Mr. Vose was then appointed, on the recommendation of the present engineer-in-chief, Mr. W. H. Preece, to the superintending engineership at Cardiff, in succession to Mr. J. Gavey, who removed to London on promotion as principal technical officer on the head office staff. Mr. Vose possessed in a marked degree the attributes that make a man a charming personal companion, but he was none the less an excellent man of business. He carried out the many delicate and important duties entrusted to him with admirable skill and tact, and he had the interests of the department he served very much at heart. He had been in failing health for a considerable time past, and for at least 12 months his condition was such as to cause much anxiety to his friends and colleagues. But throughout the long course of the insiduous disease from which he suffered he never once lost heart. It was hoped that his comparative youth would eventually enable him to throw off the disorder, and recent reports of his condition favoured this view, but on Sunday last he suffered a severe relapse and passed peacefully away on Tuesday morning. Mr. Vose was in his forty-sixth year, and he leaves a widow and three children to mourn his loss. He will be greatly missed by his brother officers and by innumerable personal friends, both within and without electrical circles. He was an enthusiastic Freemason.

REVIEWS.

Physical Units. By MAGNUS MACLEAN, M.A., D.Sc., F.R.S.E. Biggs and Co., 1896.

This is a reprint of articles originally published in the *Electrical Engineer* in the year 1894. It deals with the mechanical and other physical units for the most part in a careful and methodical manner, and it is up to date in giving the suggestions with regard to the names of magnetic units made at the meeting of the British Association at Ipswich last year. The author also discusses at length the relations of the various physical quantities to the fundamental magnitudes—length, mass, and time. But here the book shows some signs of having been hastily put together, and in some places would be a source of confusion rather than of help. It is, however, everywhere full of suggestion and interest. There is a useful collection of 32 tables at the end of the book, and a good index.

It in no way supersedes the "classic" book of Prof. Everett on the subject, but is in some ways complementary to that book, as certain points are discussed in it in greater detail. The inaccuracies in connection with dimensions are the most serious drawback to the book, and should be corrected in a second edition. Thus, on p. 17, the gravitation coefficient, k, in the formula $F = k\frac{mm^1}{d^2}$ is given as so many *dynes* on the C.G.S. system, whereas its dimensions are evidently $L^3 M^{-1} T^{-2}$, its value being

$$\frac{1}{15{\cdot}43 \times 10^6} \frac{(\text{cm.})^3}{\text{gm.}\ (\text{sec.})^2} = \frac{1}{963 \times 10^6} \frac{(\text{ft.})^3}{\text{lb.}\ (\text{sec.})^2}.$$

The confusion seems to arise from not considering that when a quantity is *completely* stated, its value is independent of any particular system of units. It is in this that the advantage of knowing the *dimensions* of the various quantities is most apparent, and, indeed, it is in this way only that dimensions come in naturally and take care of themselves. On p. 26 g is used, not for the acceleration due to gravity, but for the number denoting that acceleration in the appropriate system of units. Of course, this is often convenient, but in a book treating dimensions carefully it would have been well to draw attention to this special use of the symbol. It is really taking g as the *ratio* of the acceleration due to gravity to the unit acceleration in the system of units considered. The equation at the foot of p. 42 is wrong. It should read:

1 foot-pound =

$$32{\cdot}2 \frac{(\text{ft.})^2 \times \text{lb.}}{(\text{sec.})^2} = 32{\cdot}2 \frac{(30{\cdot}48)^2 \times 453{\cdot}6}{1^2} \frac{(\text{cm.})^2 \times \text{gm.}}{(\text{sec.})^2}$$
$$= 13{\cdot}56 \times 10^6 \text{ ergs.}$$

The alternative mode of deducing the same result given at the top of p. 43 is correct and neat and instructive. Lower down on this page it would have been better to write

$$t^2 = \tfrac{1}{32}\,(\text{sec.})^2 \text{ instead of } t^2 = \tfrac{1}{32}\text{;}$$

and

$$m = \frac{6 \times 32}{24}\text{lb. instead of } m = \frac{6 \times 32}{24}.$$

The test suggested in § 37 is a most useful and instructive one, but the equation L = M/D, or l = Y/D (to avoid confusion of M with mass), given at the foot of p. 47, does not satisfy this test. For the dimensions of Y are

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$L^{-1} M T^{-2}$ (p. 37), and those of D are $M L^{-3}$; therefore the dimensions of Y/D are $L^2 T^{-2}$. The equation should be $l = Y/g D$—*i.e.*, $l = Y/w$, where w denotes the weight per unit volume (or specific weight) of the material; and the velocity of the wave motion is given by the equation $v^2 = Y/D$. The electric and magnetic quantities are carefully defined, and their dimensions given in terms of L M T and the mysterious K and μ, whose possible natures have been so ably discussed by Mr. W. Williams in a paper referred to by the author (p. 9).

The relations in § 54 are very confused in dimensions. Surely the first line should be $B = \mu_0 H + 4\pi I$. All these equations should satisfy the test of § 37.

The practical electrical and magnetic units are carefully discussed, and references are given to important papers bearing on them. It might have been well to *tabulate* the modes of measuring the various quantities in terms of those to which names have been given, together with some of the equations connecting the named quantities, so that a student could have a birdseye view of the whole scheme of units as at present developed. The Order in Council on Electrical Units and Standards of August 23, 1894, is given in an appendix.

The discussion on thermal quantities does not seem to be quite so satisfactory, statements of dimensions being confused and mixed up with questions of units. It cannot be too strongly urged that the dimensions of a quantity have nothing to do with systems of units. Of course, we cannot *measure* without systems of units—*i.e.*, without standards of reference—but the nature of a quantity has nothing to do with whether we are able to measure it or not, and its dimensions have to do with its nature, not with its measurement. Dimensions come before units, and are superior to and independent of them.

An instance of confused dimensions occurs on p. 94, where the thermal capacity of a body is first defined as the quantity of heat necessary to raise its temperature one degree (it should rather have been "the quantity of heat given to it *per* degree rise of temperature," *dimensions*, $L^2 M T^{-2} \theta^{-1}$); and then it is said that thermal capacity per unit volume is a mere number—viz., the *ratio* of the quantity of heat necessary to raise the substance through unit difference of temperature to the quantity necessary to raise an equal volume of water through unit difference of temperature. Surely here is an example of confusing a quantity with the numerical part of its expression in terms of some standard. The dimensions of thermal capacity per unit volume are $L^{-1} M T^{-2} \theta^{-1}$, which may be reduced to $L^{-3} M$ if we take the dimensions of θ as $L^2 T^{-2}$. It is a question, however, whether in the dimensions of thermal quantities (as also in those of electrical and magnetic quantities) it is advantageous to endeavour to express everything in terms of L, M, and T only. It seems better to keep temperature (θ) as a fourth fundamental quantity until we definitely make up our minds to define it as energy of molecular vibration per unit mass ($L^2 T^{-2}$) and measure it accordingly. If we do so define it, then thermal capacity per unit mass *is* a pure number—namely, the ratio of the increase of total thermal energy given to the body to that part of it which exhibits itself in a rise of temperature. But thermal capacity per unit volume can never be a pure number.

The thermal capacity of water per unit mass is what is commonly called the mechanical equivalent of heat, and is denoted by J. It might be called the absolute specific heat of water. Its value is given on pp. 93, 94, and its dimensions are correctly given on p. 93, but are incorrectly stated on p. 101. We have

$$J = 42 \times 10^6 \frac{\text{ergs}}{\text{gm.-degree centigrade}} = 780 \frac{\text{foot-pounds}}{\text{pound-degree Fahr.}}$$

The thermal capacity of a mass, M, of any substance is $M c J$, where c is the (relative) specific heat of the substance as defined in § 102, its absolute specific heat being $c J$.

Entropy is somewhat carelessly defined on p. 98, but probably only for the sake of obtaining its dimensions, which are the same as those of thermal capacity. No mention is made of the calorie (or the therm) as a unit of heat, perhaps because its value is not at present well defined, "as no definite temperature has been chosen" (p. 93) for defining it. There are, moreover, two calories (Guillaume, Unités et Etalons), the greater calorie being the heat necessary to raise a kilogramme of water 1deg. C. (about 42×10^9 ergs), and the lesser being the amount required to raise a gramme of water 1deg. (42×10^6 ergs).

The question of a satisfactory unit of heat was brought up at Ipswich, and is now under consideration by the Standards Committee of Section A. The author consequently has considered more the nature and dimensions of the various thermal quantities than the mode of measuring them and the magnitudes of their units, which all depend on the magnitude of the unit of heat.

Taken altogether, Dr. Maclean's book is a useful addition to the literature on units, being full of valuable references and extracts, and containing a great number of useful tables.

Coopers Hill, April 16, 1896. ALFRED LODGE.

THE NATURE OF CHEMICAL CHANGE AND THE CONDITIONS WHICH DETERMINE IT.*

BY DR. ARMSTRONG, F.R.S.

(Continued from page 466.)

The dissociation of water takes place more particularly in contact with heated platinum—copper, although readily oxidised, appears to have no specific influence in promoting its decomposition. Platinum, however, occludes both hydrogen and oxygen, and may be supposed to be always charged with one or other of these gases—so that if the decomposition of water at high temperatures by platinum takes place within a circuit including one or other of these gases, the E.M.F. required to produce the change will be lower than that developed in the formation of water owing to the operation of a back E.M.F. It may be that heated copper does not decompose water, both because it does not polarise as does platinum, and perhaps, also, because the heat of formation of its oxide is lower than that of water under all conditions.

H. B. Baker's observations on the influence of moisture on the decomposition of ammonium chloride by heat (*Trans.*, 1894, 65, 615) are of great importance as the first of their kind, and must serve to direct attention to the value of further experiments of a similar character. It does not appear to me that we are yet justified in assuming that if dry such a substance would not decompose if heated; should we not perhaps rather consider that it would decompose somewhat suddenly when a sufficiently high temperature was reached—when the temperature was, in fact, a trifle higher than that corresponding to its heat of formation? The presence of moisture would promote decomposition because it is capable of interacting exothermically with one of the products—viz., hydrogen chloride. As change is influenced in both directions by moisture, the rate at which it would proceed in a case like that of ammonium chloride would, therefore, depend on the amount of moisture present; if the amount were very small, the pressure of dissociation would be attained only after the lapse of a considerable interval of time. The interesting account recently given by Rose (*Trans.*, 1895, 61, 893) of his observations on the influence of moisture on the pressure of dissociation of gold chloride—the first of their kind made to test this view—I think, clearly appears to afford confirmation of the correctness of this conclusion. With reference to this question, it may be here suggested that the occurrence of but slight decomposition when calcium carbonate is strongly heated in almost closed vessels may be due, not only to the fact that under such conditions the maximum opportunity is given for recombination, but also to the almost complete exclusion of moisture under such conditions. The practice of burning chalk wet is calculated to favour the maintenance of the "back E.M.F." developed in the interaction of lime and water to the utmost possible extent, and thus to hasten the rate of change; in other words, the acceleration is not the outcome of the removal of the gaseous products of change alone. Similar considerations apply to the incomplete *per saltum* combustion of gaseous mixtures at high temperatures.

It an interesting question whether compounds such as potassium chlorate, which decompose exothermically, will be affected by the presence of moisture or substances exercising equivalent effects; and this enquiry is clearly of special importance in connection with that into the stability of explosives. Baker's experiments have afforded negative results, but the subject is deserving of much closer experimental study. In such cases we are dealing with closed systems in a measure comparable with a charged Leyden jar, in which there are parts capable of interacting kept asunder by a non-conductor. The question is whether change be induced by communication being

* Presidential address delivered before the Chemical Society.

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set up between these distant parts by the interposition of an external conductor, or, in other words, the completion of a circuit; or whether it be the outcome of a disturbance similar to that which would have the effect in the case of a Leyden jar of smashing aside the dielectric at some point, and consequently of bringing into contact the two coatings previously kept apart. The manner in which the decomposition of potassium chlorate is promoted by the presence of various substances might be regarded as evidence in favour of the former view were it not that anything which would give rise to changes developing a back E.M.F. would at once alter and, of course, increase the rate of change, and such actions are clearly not impossible in the case in question. It would be a matter of great interest to closely study the behaviour of some of the complex carboxylic acids which lose carbon dioxide when heated, or of the keto-acids from which carbon monoxide is evolved, with the object of ascertaining whether the rate of change is in any way dependent on the amount of impurity present—whether, in fact, such compounds would prove to be the more stable the greater the care taken in their purification, including dehydration under purification; but it is not to be expected that positive results will be attained in such cases until the approach to purity becomes very close. In the case of single substances undergoing rearrangement of parts it is not unlikely that "residual affinity" may come into play as much as it does in the case of ordinary interactions, and, therefore, that such decompositions will equally depend on the realisation of particular conditions; in other words, that the stability of compounds ordinarily reckoned very unstable may be very considerable in the pure state.

The instability of liquid ozone, to which attention has been drawn by Dewar and Liveing's observations, for example, may not be an intrinsic property of ozone in the liquid state, but may be conditioned by the circumstance that being liquid it is more readily brought into circuit or coupled up with impurities which happen to be present, so that opportunity is given for change to set in. The decomposition of liquid ozone would seem, in fact, to be comparable with that of a liquid system of sulphur dioxide, oxygen, and water, in which change occurs somewhat readily, although a gaseous mixture of the same substance is stable, according to H. B. Dixon.

The argument that changes generally all occur within compound circuits may, perhaps, even be extended to complex molecules undergoing change locally, and, indeed, such a step is but an application of the principle already made use of in explanation of fermentation. Thus it is now well known from E. Fischer's observations that when certain salts of gluconic and similar acids are heated they are converted in isomeric acids in consequence of a change in orientation being brought about which is purely local, affecting, as it does, only the single asymmetric carbon atom to which the carboxyl group of the acid is attached. The change is therefore clearly one which takes place within a local circuit, and apparently requires for its occurrence the establishment of certain special conditions. Lastly, it may be pointed out that cases of so-called tautomeric, or, as I prefer to call them, isodynamic, change would be easily explicable in terms of the theory here advanced, without in any way regarding them as spontaneous manifestations of inherent intramolecular activities.

I would here direct attention to the interesting discussion which has taken place within recent years as to the origin of flame spectra, as to whether such spectra are heat effects pure and simple, or conditioned by the occurrence of some form of chemical change (compare Smithells, *Phil. Mag.*, 1894 [5], 37, 245, where reference is made to the work of several observers bearing on this subject), questions on which the last word is clearly far from being said. This, moreover, is but one aspect of the wider and deeply interesting problem as to the nature of the changes occurring in flames generally, and of those which give rise to luminosity. It has long been taught that the hydrogen is the more combustible element of hydrocarbons, and, doubtless, this doctrine has been too dogmatically and exclusively taught; but the more modern opposite view, which is tending to become fashionable, is probably based on an equally narrow interpretation of the phenomena, which, it can scarcely be doubted, are of a very complex character and likely to defy our powers of analysis for some time to come. Personally, I see no absurdity in the idea that the hydrogen is first burnt and carbon liberated, and the water subsequently unburnt by the carbon; but I prefer to represent such combustions as occurring within systems comprising at least oxygen, hydrocarbon, and water, and the products as being water, carbon monoxide, and hydrogen. In such a case, I think it would be incorrect to speak of either constituent as the more combustible; the nature of the change must depend on the nature of the circuit within which the change occurs, and this may well vary with the conditions.

I have always felt attracted to the views of the origin of luminosity in flames put forward by Frankland so far back as 1867, in a remarkable course of lectures delivered at the Royal Institution, which were fully reported at the time in the *Journal of Gas Lighting*, and it has seemed to me that the theory has received far less attention than should have been accorded to it. Interest should be revived in the subject by the recent observations of V. B. Lewes (*Proc.*, Roy. Soc., 1895, 57, 450) on the decomposition of acetylene at high temperatures, which have led him to suggest that this compound plays the chief part in promoting luminosity in hydrocarbon flames, and that the heat liberated during its decomposition endows the carbon particles produced from it with an incandescence far higher than corresponds to the temperature of the flame. It appears to me that while accepting this as a partial explanation, it is unnecessary to suppose that luminosity is consequent on the production of presumably solid carbon particles; the conversion of acetylene, or other hydrocarbons, at high temperatures into hydrogen and carbon, although a decomposition in the ordinary sense of the term, is doubtless a change involving the interaction of several molecules, and the consequent formation of carbon molecules of a high order of complexity together with hydrogen molecules; and it is exothermic because the energy liberated in the combination of the carbon atoms among themselves, and also of the hydrogen atoms, is far in excess of that absorbed in the decomposition of the hydrocarbon molecules. The initial luminance may therefore well be that of the molecules at the moment of formation prior to condensation, although the continued incandescence of the carbon molecules after their reduction to the solid state probably contributes largely to maintain luminosity, giving to hydrocarbon flames their special value perhaps. But this is to explain the phenomena in terms of Frankland's theory, as I understand it, and as appears to be necessary in order to explain the luminous appearance of a hydrogen-oxygen flame burning under pressure, and other cases in which the products of combustion are gaseous.

Of the many directions in which the introduction of electrical conceptions into chemistry promises to be of service, the determination of the "electromotive efficiency" of chemical change appears to be one of the most important.

Braun in Germany, and in this country our late distinguished fellow, Alder Wright, whose loss we so much deplore, have devoted much attention to the determination of "chemical affinity" in terms of E.M.F., following the method first adopted by Wm. Thomson (now Lord Kelvin) and successfully applied by him to the Daniell cell. Thomson's calculations involved the assumption that the energy of chemical change becomes wholly converted into electrical energy, but the comparisons which have been since made *seem* to show that in cells other than the Daniell this is rarely, if ever, the case. Helmholtz and others, in fact, have proposed to draw a distinction between free and bound energy, the latter being that portion of the total energy of the system which is not convertible into electrical energy but becomes frittered down into heat in chemical changes. It has always seemed to me that most physicists who have discussed these matters have had far too little feeling as regards the nature of chemical changes, and that the conclusions have been too often based on *a priori* considerations. Obviously, it is necessary to know the precise character of the changes going on under particular conditions in any cell before the attempt can be made to ascertain whether the E.M.F. developed is the precise equivalent of their "chemical energy." Our knowledge as to what goes on in solutions is so vague, however, that at present we can never assert that we know precisely what is happening in a particular system." As Herroun has pointed out in an important paper on "The Divergence of E.M.F.'s from Thermo-chemical Data" (*Phil. Mag.*, March, 1889, 209), there is reason to believe that in the case of a number of metals, silver and mercury, for example, it is probably altogether wrong to base calculations on the assumption that the heat of formation of a hydrated salt, or of the salt in a solution of the concentration of that which is ultimately formed in the cell in which the metal is dissolved, is the heat of formation to be made use of in the calculation of E.M.F.; we must, in many cases, rather assume that the anhydrous salt is alone formed in the circuit. In like manner Robertson and I have contended (Royal Society's *Proceedings*, 1891, 50, 108) that in the lead sulphuric acid-lead peroxide cell the active acid is not that actually filled in, but a lower hydrate or the anhydrous acid; in this manner it is possible to account for the cooling observed during the discharge of an "accumulator," as the separation of molecules of the acid from a solution (by dissociation) would, of course, involve cooling.

If, as Faraday has said, the forces termed chemical affinity and electricity are one and the same, there does not seem to be any reason why there should not be an integral conversion of the energy of chemical change, nor any necessarily valid objection to the view that an explanation of the discrepancies which have been observed is to be sought for in phenomena that prevent an integral "conversion" from being realised. Meanwhile, the determination of E.M.F. may be of great service as enabling us to discriminate between a number of conceivable modes in which change may occur in a given case. Thus it is clear, for example, that whereas a metal like zinc is dissolved by, say, sulphuric acid in a circuit of which the hydrated, not the anhydrous, acid forms a part, metals like silver, mercury, lead, and even nickel (compare Herroun, *loc. cit.*, p. 226) require

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to be coupled with, it may be, the anhydrous acid, but in any case with one which is less hydrated than that which is active in the case of zinc; the anhydrous salts formed in such cases apparently undergo hydration outside the circuit of electrolytic change, and their hydration only affects the temperature of the cell, so that the phenomena are comparable with those which attend local action in a cell in which ordinary or imperfectly amalgamated zinc is used.

In other words, it is not a mere question as to what is present n a solution; the *compatibility* of the various substances must also be considered, and of this we know very little at present. Incompatible molecules may get in the way and hinder change, but only compatible molecules can co-operate in changes, so that we cannot simply write $C = \frac{E}{R}$, and treat R as the resistance of the solution as a whole in which the change takes place; it may often be the resistance of circuits within the solution, the precise nature of which it is difficult, if not impossible, to determine.

It is not only on account of the very different behaviour of different metals towards acid solutions, however, that the discussion of the electromotive efficiency of various combinations is of interest; it is also possessed of a side interest as throwing light on the behaviour of the water itself, which is in so many respects peculiar. If it be possible for sulphuric acid molecules, for example, to separate from a solution to dissociate out—and act separately in the presence of water, without producing any direct effect on the E.M.F. of the cell within which the change occurs, the necessary energy being furnished by the liquid, which thereby becomes reduced in temperature, it is clear that the dissociation of *hydrates* is in a measure a phenomenon of a peculiar order. It might be supposed that the energy concerned in such changes is the so-called "bound" energy of Helmholtz, but this can hardly be the case, as that which is "bound" when the acid is included within a circuit with lead is apparently "free" when included in a similar circuit containing zinc in place of lead.

In discussing elsewhere the question whether a line cannot be drawn between cases in which interaction will, and those in which it will not, take place between two pure substances, I have pointed out that, although there is little to guide us, it seems not improbable that water has special properties which enable it to act directly, at least in cases in which dissociable composite electrolytes could be at once formed. If this be the criterion adopted, sulphuric anhydride may be expected to combine at once with water without the intervention of any other substance, but not with hydrogen chloride; and alcohol to mix with water without undergoing hydration, just as ammonia and hydrogen chloride mix without combining.

This distinction is made on the assumption that while all liquid systems of the formula xH_2O,ySO_3 are conductors, the compound SO_3HCl, as well as mixtures of its constituents, and also pure mixtures of alcohol and water, are non-conductors. In drawing this conclusion, it is, of course, assumed that we can generalise from actual observations with liquids as to their ability to co-operate in forming electrolytic circuits. The difficulty which apparently is met with in coupling carbonic oxide may conceivably arise also in the case of liquids; but it does not appear probable that such will be found to be the case, as mixtures of dielectrics, such as water and hydrogen chloride, so readily conduct a current. Of course, also, no such distinction as is above drawn can be made if pure water be slightly dissociated, as some contend it is.

In attempting to discuss these questions, however, we are entering on a field of enquiry in which, at present, we are all but strangers; we are, in fact, dealing with that remarkable class of combinations, the so-called molecular compounds, whose existence it is impossible to deny, difficult though it be to precisely define them. But that they play an all-important part in the course of chemical change there can hardly be a doubt, and it has long seemed probable to me that, as I have previously suggested, we may eventually recognise in them the mechanism through which the degradation of energy is effected in chemical changes generally.

With regard to the spontaneous occurrence of dissociation in a case such as that of sulphuric acid, it is all important probably to bear in mind that the compound represented by the formula H_2SO_4 will combine both with sulphuric anhydride, on the one hand, and with water on the other, so that a number of systems of the general formulæ xH_2O,ySO_3 are possible. There is thus an essential difference been sulphuric acid and ammonium chloride, for example, as the latter has no tendency apparently to combine with either of its constituent molecules, and, in fact, constitutes a rigid system. It may well be that it is only in cases comparable with that of sulphuric acid that dissociation occurs spontaneously without the intervention of any other substance, such systems being in the condition postulated by Fitzgerald—*i.e.*, so arranged that changes take place within them of their own accord—and being the only ones which can be formed directly from their two proximate constituents without the intervention of any third substance. The fact that liquid water itself almost unquestionably consists of a mixture of complex molecules and of fundamental molecules such as are represented by the formula H_2O must also be taken into account. In short, it would seem that a sulphuric acid water system may be likened to a complex system of springs, and ammonium chloride to a simple spring; whereas the latter can change only in one direction, and must always be in compression or extension, the former may have one part in compression and another in extension, and fluctuating changes may easily go on within it, and, in consequence, energy be gradually frittered away. Such a fluctuating system may be a necessary element in every chemical change.

It is impossible to doubt that, as a means of determining the precise character of the changes which may be going on in a complex system, the determination of the electromotive efficiency of various combinations will prove to be of the greatest importance. As a further illustration of the manner in which we may derive assistance from the introduction of such physical considerations, attention may be directed to the complex changes attending the action of metals on nitric acid, a subject which has long troubled the minds of chemists, and which has always exercised a special fascination over me. There is little, probably no hope, that we shall ever arrive at a satisfactory solution of this complex problem so long as we regard it from a purely chemical point of view.

The observations of fundamental importance which must be first taken into account in discussing such changes are those of Millon (1842), Russel (1874), and Veley (1891), showing that silver, copper, etc., are not soluble in nitric acid free from nitrous compounds. In my opinion, however, these observations cannot be regarded as proof that nitrous acid is the solvent of the metal; the conclusion to be derived from them, I think, is of a far more interesting character.

Silver has a negative heat of dissolution, the value calculated from the data given by Thomsen being (at 18deg.):

$$2Ag + 2HNO_3, aq = -51,580 \text{ gram-deg. C. units.}$$

This value, however, is reduced to −40,700 if the heat of dissolution of silver nitrate be deducted. As the reduction of nitric acid to nitric peroxide ($2HNO_3 - O = N_2O_4$, H_2O), according to Thomsen, involves an expenditure of but 10,010 units, the oxidation by *nitric acid* of the hydrogen displaced by silver dissolving in nitric acid would give 68,360 − 10,010 = 58,350 units, which is considerably in excess of the value − 51,580, and still more so if the lower value corresponding to the formation of the anhydrous salt be taken. Silver, therefore, should be easily soluble in nitric acid if this acid can act as *depolariser*. A still stronger case may be made out by considering the values for mercury and copper, as the heats of dissolution of these metals, although negative, are considerably lower than that of silver. Such facts appear to leave little room for doubt, and to justify the important conclusion that the nitrous compound is the active depolariser.

To conclude that such metals as bismuth, copper, mercury, and silver are dissolved by nitrous acid, not by nitric acid, is to attribute to nitric acid properties which would make it entirely peculiar among acids, for it appears to be a characteristic property of acids generally to dissolve metals generally whenever the conditions are such that exothermic change can occur.

It seems to me that such problems can only be treated from an electrolytic standpoint, and the fact that we do not always so treat them is evidence of a most extraordinary failure on the part of chemists to apply Faraday's teachings. Unfortunately, the physicists have also neglected this subject, having apparently left it to the chemists to discuss the changes attending the interaction of metals and acids; the result is blank ignorance of all that is fundamental with regard to such matters on the part of both chemists and physicists.

Objection has been taken to the use of the hypothesis of nascent hydrogen in explaining the effects produced with nitric acid. No doubt the conception is much misunderstood and misused, but it is, after all, a conception which cannot be put aside. Hydrogen undoubtedly is often displaced and brought into action without ever escaping from the circuit in which, and along which, it is displaced; "nascent" hydrogen, in fact, is but hydrogen in circuit, the hydrogen which is active at the surface of the plates in a Grove gas battery, or which effects reduction when condensed in charcoal, being as much "nascent" in this sense as that displaced from water, say, by sodium amalgam in presence of a reducible substance. Moreover, the "activity" of such hydrogen depends entirely on its origin. This cannot be denied in face of the fact that if in cells of the Daniell type, for example, cadmium be substituted for zinc, not only is the E.M.F. developed lower, but lower to the extent to which the heat of dissolution of cadmium in the acid used is less than that of zinc.

In dissolving metals in nitric acid we are but dealing with "cells" of the Grove type. If nitrous acid be in any way directly active as solvent of the metal, in all probability it can but act along with the nitric acid, and not to its exclusion; but it is useless to discuss this question further until we are sure

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that nitrous acid actually exists, and there is much reason to doubt this. As copper is readily dissolved by diluted sulphuric acid in presence of oxygen, although insoluble in the acid alone, it is inconceivable that nitric acid should not be equally active in presence of a sufficiently active depolariser—when the conditions are such, in fact, as are secured by the presence of oxygen, together with copper and sulphuric acid, and a system is formed within which exothermic change is possible.

It appears to me to be highly probable that the active depolariser in the cases considered is *nitrogen dioxide*, and that this becomes reduced to nitrogen monoxide, which in turn is oxidised by the nitric acid. Whether these actions all take place in one circuit has yet to be determined, but it is not unlikely that such is the case, as the electromotive efficiency of the Grove cell, as determined by Thomsen, corresponds with the assumption that the nitric acid becomes reduced to nitrogen dioxide ($2NO_2,OH_2$). The dissolution of copper on such a view would be represented as follows :

$$Cu \left| \begin{matrix} NO_3H \\ NO_3H \end{matrix} \right| ONO \left| \begin{matrix} NO_3H \\ NO_3H \end{matrix} \right| Cu =$$
$$Cu \begin{matrix} NO_3 \\ NO_3 \end{matrix} \left| H_2O \right| NO_2 \begin{matrix} NO_2 \\ NO_2 \end{matrix} OH_2 \left| Cu. \right.$$

There is thus at once a great increase in the amount of nitrogen dioxide, assuming only a minute proportion to be present in the acid at the outset, and the action can therefore take place at a rapidly increasing rate, and very soon attains a maximum. As soon as the nitric acid is saturated with the dioxide this begins to escape, but, *pari passu*, the acid grows weaker, and soon the dioxide is subjected to the attack of water, whereby nitrogen monoxide is formed and also escapes, the acid being too weak to entirely reoxidise it. It is probably from this point onwards that the E.M.F. begins to fall. It is conceivable that monoxide is formed even at an earlier stage in consequence of the exhaustion of the acid at the surface of the plate, and that the E.M.F. is also influenced in this manner. In the case of metals having positive heats of dissolution the phenomena are probably far more complicated, but, as I have pointed out in discussing this question in a note on the nature of depolarisers (*Proceedings*, 1893, 148, 188), it is possible, by applying electrochemical considerations, to deduce comparatively simple explanations. In this note I have also called attention to the case of sulphuric acid as possibly analogous to that of nitric acid, inasmuch as it only undergoes reduction when the conditions are such that the presence of *sulphuric oxide* is possible—*i.e.*, that the active depolariser, when metals such as copper (which have negative heats of dissolution) are dissolved in hot, concentrated, sulphuric acid, is the oxide, not the acid itself. Divers and Shimidzu, in a paper on the action of pyrosulphuric acid on certain metals (*Trans.*, 1885, 47, 636), have contended that the trioxide acts directly ; they formulate the action as occurring between the metal and a double molecule of the oxide which they represent as sulphuryl sulphate, as in the equation

$$SO_2(SO_4)+2Ag=Ag_2SO_4+SO_2 ;$$

but such an assumption appears to be entirely unnecessary, even if it be in any way warranted by facts.

The fact that metals dissolve in solutions of perchloric acid without reducing it, may be regarded as confirmatory of the view here put forward, as there is no reason to suppose that such solutions contain a reducible oxide ; solutions of chloric acid, on the other hand, which undergo reduction by metals, are doubtless comparable with "nitrous" nitric acid.

If it be found that such contentions as these are correct, our views of the manner in which acids act will be much simplified. Whatever view be taken of electrolysis—whether or no it be dependent on the ions becoming free like the molecules of a gas—it is difficult to understand that one compound should function in several different ways in the same circuit. If nitric acid, for example, be resolved into the ions H and NO_3, and these are arranged in any form of polarised chain along the direction in which the current acts, why should the hydrogen which separates from the NO_3 ion, giving place to the metal, act otherwise on a contiguous NO_3 ion than to reproduce nitric acid? A complete "change of front" would be necessary if it were to act in any other way. A company of soldiers who in rigid mechanical obedience to the word of command perforce *face* the enemy to receive their charge, will be bayoneted only in front by those who attack in an equally mechanical manner ; if otherwise, the word of command—the direct effect of the E.M.F.—is only partially obeyed. And to say, in order to meet such an objection, that a molecule may undergo ionic disruption in several ways is to entirely confuse our conceptions in a manner which is most undesirable so long as the facts do not *compel* us to make such an assumption.

(To be continued.)

New Element.—Mr. Eugène Demarcay believes on evidence, partly chemical and partly spectroscopic, that he has discovered yet another metal among the "rare earths."

THE PHYSICAL SOCIETY.

At the ordinary meeting on April 24 Captain W. de W. Abney, president, occupied the chair.

A paper by **Mr. R. A. Lehfeld** on **"Symbolism in Thermodynamics"** was, in the absence of the author, read by the **Secretary**. In this paper the author proposed a system of about 24 separate symbols for the different quantities in thermo-dynamics.

In the discussion that followed **Prof. Silvanus Thompson** said he was not at all favourably impressed with the symbols proposed. In particular, it was becoming usual to restrict the use of Greek letters to the representation of specific quantities or angles, and the author's proposal seemed in this way a retrograde step.

Prof. Perry said he did not care for the suggested symbols.

Mr. Elder thought the author's system would be a very severe tax on the memory, for he did not make use of suffixes, as was ordinarily done, which in a great measure define the symbol to which they are attached.

Mr. Appleyard read a paper on the **"Adjustment of the Kelvin Bridge."** In a recent paper read before the society Mr. Reeves had described a modified form of Kelvin bridge, in which a double adjustment was necessary. The author proposed to employ two wires stretched side by side, with a sliding contact in connection with the galvanometer on each. These contacts are rigidly connected together, so that the segments into which one wire is divided necessarily bear to one another the same ratio as do the segments of the other wire. Hence a single adjustment is sufficient to give balance.

Mr. Reeves said that apparently the author had completely missed the object of his (the speaker's) paper ; for the object there aimed at was to make use of such sets of resistance coils as were always to be found in any laboratory. In the author's arrangement it would be necessary to carefully calibrate the two wires, and also since the resistances used must necessarily be small, to determine the resistance of the contacts.

Prof. Ayrton forwarded a communication, in which he said the author's suggestion was ingenious, but did not obviate the necessity for much of Mr. Reeves's "addition." Further, Mr. Reeves's proposal to employ ordinary resistance boxes was not made because such resistances were absolutely necessary, but because, since they were to be found in any electrical laboratory, their use saved the expense of such a wire resistance accurately calibrated as Mr. Appleyard employed.

Mr. Appleyard, in his reply, said that his instrument was designed for use in a factory, where the time saved in making a series of tests was of more importance than the cost of the instrument.

Mr. J. Frith read a paper on **"The Effect of Wave-Form on the Alternate-Current Arc."** The author finds that an arc has the power of modifying the wave-form in a circuit in which it is included. Thus, in the case of a dynamo, for which on open circuit, the curve of E.M.F. was decidedly peaked, it was found that when this dynamo was employed to feed an arc that the curve became changed to a flat-topped form It is interesting to remember that the candle-power of the arc is greater when the wave-form is flat-topped that when it is peaked. By altering the resistance in series with the arc it is possible to alter the character of the curve, for as the resistance in series with the arc increases, the arc affects the wave-form less and less. In some recent experiments, described by Dr. Fleming, a resistance of about seven ohms was used in series with the arc, so that the wave-form of the generator, which is not an efficient form, was forced on the arc. In practice, however, where a resistance is not used in series with the arc, this is not the case, and the differences between the efficiency obtained for alternate-current arcs in the laboratory and that claimed in practice may thus be accounted for.

Mr. Blakesley said it seemed as if the more nearly the alternate current resembled a direct current—*i.e.*, the longer in each period the current remained constant—the greater was the efficiency of the arc

Mr. Price asked what was the cause of the reaction of the arc on the wave-form

Mr. Tremlitt Carter asked whether previous observers' results were vitiated by this action of the arc on the wave-form?

Prof. Ayrton, in a communication forwarded, said the author's suggestion was of great importance as bearing on the question of the efficiency of the alternate-current arc.

Prof. S. P. Thompson said that the dynamo employed by the author was one in which there was a large quantity of iron in the armature, so that the self-induction was large. Was it not on account of this large coefficient of self-induction, which would tend to keep the current constant, that the arc was able to alter the wave curve? If an arc was connected to the mains of a supply station in which a number of machines in parallel were feeding a number of lamps, would the arc still be able to affect the wave-form of the current?

Mr. Tremlitt Carter asked if the author had tried the effect of replacing the arc by a resistance such that it would absorb the same volts as did the arc, and comparing the curves for the current and impressed P.D. with those obtained with the arc.

The **Author**, in his reply, said that the effect of the self-induction of the machine was shown in the curves. Current curves had not been taken with the arc straight on the machine. The current and self-induction were the same for all the curves, the voltage of the machine being increased by increasing the field when resistance was placed in series with the arc. When, as was commonly the case, special machines were used to supply arcs, and

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the load consisted solely of arcs, the arcs could alter the character of the wave-form. If the arc was replaced by a resistance, the wave-form was of the same type as was obtained for the E.M.F. of the machine on open circuit.

The society then adjourned till May 8.

ELECTRIC LIGHTING EXTENSIONS IN ISLINGTON.

The following is the report which Mr. Gay, the electrical engineer to the Vestry, has prepared on the suggested extensions of the electric lighting in the parish:

In accordance with your instructions, I have gone carefully into the cost of extending the mains on both sides of the Caledonian-road, Camden-road, Essex-road, and the completion of the Holloway-road from the Nag's Head public house to the Archway Tavern. This includes pipes and mains for the street-lighting in all cases, lamp columns, lamps and fittings and all accessories, as well as labour and relaying. The cost of this for the different streets is as follows:

Caledonian-road	£8,796
Camden-road	4,035
Essex-road	6,549
Holloway-road	4,914
Total mains	£24,294

As we have already a large number of lamps applied for that we cannot connect to our present plant, I do not think it would be wise to put in anything less than two 300 kilowat alternators and two 500-h.p. engines, thus rather more than doubling the working capacity of the station. This I think will be absolutely necessary for the autumn. The total estimated cost of engines, alternators, boilers, etc, is as follows:

Two 300-kilowatt alternators, two exciters, and accessories, say	£5,000
Four Lancashire boilers and accessories, say	2,750
Two 500-h.p. engines and accessories, say	6,000
Contingencies, steam-pipes, etc., say	1,500
Meters, transformers, low-tension mains, and accessories, say	3,000
Total	£42,544
Extension of buildings, in accordance with architect's estimate	5,500
Grand total of	£48,044

This is a most serious increase, and, as you will see, is more than half made up of mains a very large proportion of which I fear will be comparatively unproductive for some time to come

As I have already stated, the machinery more than doubles the capacity of the station, the actual figures being:

Present total capacity	500	kilowatts
Available after allowing reserve	375	kilowatts
Proposed extension	600	kilowatts
Total	1,100	kilowatts

of which, after allowing reserve, 800 kilowatts will be available, as against 375 available now.

The extension will enable us to run, roughly, 21 000 35 watt lamps at one time, after allowing for full reserve.

Considering the large demand we have in the present district, and which ought to increase very much towards the autumn, I do not feel justified in recommending the committee to lay out such a large sum upon mains in districts where the demand is problematical, and I should be glad if the committee would reconsider this question, as far as the extension of mains is concerned.

Mains are laid at the present time along seven miles of frontage, and the new mains are equivalent to a further 10 miles of frontage, or a total laying of 17 miles within 12 months of the opening of the works, supposing that this scheme is carried out. This, I venture to think, represents a much greater distribution than is justified within the period. Such an immense outlay for additional mains must seriously delay the date at which the department becomes profitable, and I think it would be wiser to see the result of a complete year's working before a further £25 000 is expended for new mains. In any case, I would respectfully suggest that the question of the extension of mains be considered separately to that of the plant, which is absolutely necessary, and if placed on order this month could not possibly be ready before October.

KINGSTON-UPON-THAMES.

The following is the second annual report of Mr. J. E. Edgcome, A.M.I.M.E., borough electrical engineer, to the Lighting Committee of the Corporation upon the working of the electricity undertaking of the borough:

Machinery.—Since the last report a Reeves patent filter has been fitted in the boiler-house for the purpose of extracting the oil from the condensed water before returning it to the boilers. A Maignen water-softening plant has been erected near the boiler-house for the purpose of softening and purifying the raw feed water taken from the river, in order to avoid any future trouble from scale forming in the boilers. A second coal-shoot has been laid down behind the works, so that a stock of coal of 100 tons can be kept in hand in case of strikes or other unforeseen circumstances interfering with the delivery of fuel.

Launch Charging.—The arrangements for launch charging will be completed within a month, and a supply of current for electric launches will be available from the works during the boating season.

Mains.—A number of cable extensions have been carried out, the mains having been laid, for the purpose of connecting fresh consumers, to Kingston-hill, Manorgate-road, Cambridge-road, Fassett-road, Grove-crescent and Lingfield avenue. The two sub-stations in London-street and the Horsefair have been completed and equipped with transformers and high and low tension switch and fuse gear, and connected to the low-tension mains. An extra 25-kilowatt transformer, with switch and fuse gear, has been placed in the sub-station under the town hall Further low-tension mains have been laid in Thames-street, so that that thoroughfare has now distributing mains equal to ·6 square inch, and capable of supplying current to 1,800 8-c.p. lamps. A service main has been laid to the sewage works, which are now lighted electrically throughout The labouring-class dwellings built by the Corporation in Pheasant-lane are also lighted electrically. The number of consumers has increased from 77 at the end of 1894 to 99 on December 31, 1895, on which date the number of lamps installed was equal to 4,800 of 8 c.p.

Works Expenditure and Receipts.—The figures given in the following tables are for a period of 12 months from January 1 to December 31, 1895.

ELECTRICITY SUPPLIED.

Quarter ending	Units.	Electricity.	Meter rents.
March 31, 1895	18,962	£468 4 1	£14 9 0
June 30, 1895	9,410¼	232 16 10	15 7 6
Sept. 30, 1895	10,679½	265 12 3	15 15 0
Dec. 31, 1895	28,394½	650 17 11	16 8 6
	67,446¼	£1,617 11 1	£62 0 0

UNITS SUPPLIED FROM JAN. 1 TO DEC. 31, 1895.

To private consumers	67,446
To public arc lamps	66,638
Total units sold	134,084

TOTAL RECEIPTS FOR CURRENT SUPPLIED.

From private consumers	£1,617 11 1
Charged for arc lamps, £20 per lamp per annum	720 0 0
Total electricity receipts	£2,337 11 1

Revenue per unit = 4 184d.

REVENUE SUMMARY FOR 1894 AND 1895.

	1894.	1895.
Total works cost	£2,573 3 4	£2,704 3 1
Total receipts	1,985 19 7	2,441 19 3
Deficit on works	587 3 9	262 3 10
Repayment of principal and interest	711 14 10	1,120 6 0
Total deficit on year	£1,298 18 7	£1,382 9 10

Dr.

Pence per unit. REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1895.

		£ s. d.
1·968	Coal and other fuel and carting	1,099 17 11
0·266	Oil, waste, water, disincrustant packing, gauge glasses, sweep, and petty stores	149 2 2
1·069	Wages for generation of current	597 7 0
0·251	Maintenance of plant, including wages, small repairs, incandescent lamps, etc.	140 14 7
		£1,987 1 8
0·503	Maintenance of mains, including wages of lamp-trimmer, carbons, etc.	280 19 6
4·057	Works cost per unit	—
0·524	Proportion of salary of engineer and assistant, salary of clerk, £225. 4s. 9d.; stationery, printing, and advertising, £36 12s. 8d.; general establishment charges, including petty cash, office fuel, stamps, etc., £31. 7s.	293 4 5
0·193	Rates and taxes, £81. 2s. 4d.; insurance, £27	108 2 4
2·005	Repayment of principal and interest on loans	1,120 6 0
—	Stores, lamps, etc.	34 15 2
		£3,824 9 1

Cr.

	£ s. d.
Sale of current, per meter, less discounts, and after providing for bad debts	1,617 11 1
Rental of meters	62 0 0
Amount for lighting 36 public arc lamps, at £20 per lamp per annum, from Jan. 1, 1895, to Dec. 31, 1895 (inclusive)	720 0 0
Sundry sales	42 8 2
Deficit balance	1,382 9 10
	£3,824 9 1

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LEGAL INTELLIGENCE.

COMPETING COMPANIES.

At the Westminster County Court on Wednesday, before his Honour Judge Lumley Smith, Q.C., the case of the London Electric Supply Corporation *v.* Prentice came on.

This was an action on the part of the plaintiff company to recover the sum of £15, being £10 for breach of contract and £5 in respect of work done on behalf of the defendant at his private house, 60, Park-street, W.

It appeared from the opening statement of counsel that in February last the plaintiffs, through their canvasser, obtained from the defendant a contract in writing to supply electric light to his house in Park-street, but a few days after the contract was signed the defendant wrote a letter of repudiation on the ground that he had made an error in signing the contract with the plaintiff instead of with the Westminster Electric Supply Corporation.

Mr. Carter, chief clerk in the employ of the plaintiff firm, said the defendant then signed the contract for a year's supply of light, but a few days afterwards he repudiated it on the ground that he intended to make the contract, not with the plaintiffs, but with the Westminster Company.

The **Plaintiffs' Canvasser** was called, and said he had on several occasions called upon the defendant in respect of the installation of the electric light. He was aware that the Westminster Company had previously supplied the house with light, but he took the order quite in the usual way.

For the defence it was contended that the contract was signed under a misapprehension, and that the defendant intended to give the order to the Westminster Company, who had supplied the light previously.

The **Defendant** and his **Clerk** were both called, and gave evidence to this effect.

After hearing further evidence at some length, his **Honour** said the Westminster Company appeared to have acted as well as any company could act in the matter. He (the Judge) was quite convinced that the contract with the plaintiff had been signed in error, and could not be enforced; therefore judgment would be for the defendant, with costs.

ACTION AGAINST THE SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

In the Chancery Division of the High Court of Justice on April 25 Mr. Justice Romer had before him the case of the Electric Construction Corporation, Limited *v.* the South Staffordshire Tramways Company, who sought to recover certain sums due upon an agreement entered into between the parties in February, 1892.

Mr. Eve, Q.C., and Mr. Theobald appeared for the plaintiff corporation; and Sir F. Lockwood, Q.C., Mr. Oswald, Q.C., Mr. Jenkins, and Mr. T. D. Muuns appeared for the defendants.

Mr. Eve, in opening the case, said a number of defences, or amended defences, had been put in, and the last of them practically came to this: that the agreement was under circumstances so capable of fraud that no court would enforce specific performance. The defendants counterclaimed, setting up that the agreement was not binding on them, asking for rescission and damages. The defendant company was incorporated under a special Act in 1889 for the purpose of acquiring the assets and liabilities of a limited company which was incorporated early in the eighties for the constructing, working, and maintaining certain tramways in Staffordshire. Under further orders further tramways were constructed, and the limited company was dissolved by Clause 4, Section 13, of the Act. Having obtained that Act in August, 1889, it became necessary for the company to set about seeing what form of motive power they should substitute for the steam power. At this time there had been introduced by various companies and firms a system of working tramways by means of overhead electrical works and other electrical appliances, and on October 17, 1889, at a Board meeting of the company, held at Darlaston, it was agreed to invite tenders for the supply of traction power and maintenance. In May, 1889, a company was registered for the purpose of introducing a system of electrical working into this country, and that was the first-named plaintiff company in the action. Mr. Joseph Smith was the managing director, and he subsequently changed his name to Ebbsmith, being known as Mr. Joseph Ebbsmith. The works director was Mr. Thomas Parker and the engineering adviser of the company was Mr. Carruthers Wain. By one of the many amended defences it was suggested that this company was got up for the purpose of foisting the undertaking on the defendant company, or, so to speak, in order to bleed the defendant company in the matter of the traction part of the undertaking. One of the equities relied upon against the plaintiff company was that Mr. Spencer Balfour was a founder of the company, and that Mr. C. Wain occupied a like position. The company having been floated went on its way, and it was not until something like 18 months after the first suggestion that the defendant company should look out for someone who would supply electricity that the two companies were brought together, and the negotiations were commenced that ultimately resulted in the agreement of February, 1892. In March, 1895, the plaintiffs, under a clause in the agreement, elected to determine, and if the notices given were valid, then the plaintiffs were entitled to the sums they sued for, and for a declaration that they were entitled to determine the agreement. He asked for an account of what was due in respect of the mileage during the working of the tramways, that they were entitled to determine the contract, that they were no longer bound by Clause 8 of the contract, which provided that for a period of five years they should manage the work, and inasmuch as the mileage for five years on 250,000 was a portion of the price payable to the plaintiffs, and by reason of the determination of the contract they were not able to receive that price, they asked for the difference between the actual mileage run and the minimum mileage in five years—namely, £13,186, being 4½d. per mile. The defendants' answer to that was that the agreement was over-reaching and ought to be set aside, in respect to which they counterclaimed.

Evidence was then called in support of the plaintiffs' case

Sir Frank Lockwood, Q.C., opened the defence, and said that his contention would be that in the negotiations which led up to the contract of February 26, 1892, the interests of the South Staffordshire Company were betrayed and the interests of the plaintiff company ignored. The view he presented to the Court was that, so far as the plaintiff and the defendant companies were concerned, the beneficial nature of this contract to either of them was absolutely ignored, and the only object was to capture the South Staffordshire Tramways Company and its advantageous concessions. What he had to do was to satisfy the Court that in the negotiations for the contract the interests of the company were not only betrayed by those who were representing it, but the interests of the plaintiff company were entrusted to one who knew perfectly well how the South Staffordshire Company was being treated. After giving a history of these proceedings, and of the mode in which the plaintiff company was formed and the contract made, the learned counsel submitted that if he established that the contract was oppressive, and that the company could not survive under it, then the plaintiff company must fail, and he was entitled to rescission of the contract.

The judgment and evidence in the former trial were then put in and read, and evidence called for the defence.

The hearing of the case, which had already occupied three days, was adjourned until yesterday (Thursday), and had not concluded at the time of our going to press.

COMPANIES' MEETINGS AND REPORTS.

INDO EUROPEAN TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held on April 29 at Winchester House, Mr. J. H. Tritton presiding.

The **Chairman,** in moving the adoption of the report, said the past year had been a quiet one, and they had, fortunately, to deal with a satisfactory revenue. Their receipts for 1895 amounted to £123,734, an increase on the previous year of £4,616. They owed this increase to the trans-Indian business, and they owed that, again, to the discoveries of gold in Australia. With respect to India, their trade was pretty much where it was before. There was a slight increase, but the income derived from the traffic had not made up the leeway which set in with the reduction of rates made in the year 1886. The code tariff over their wires India took rank amongst the lowest tariffs in the world, and for each hundred miles of line was so very much less than the charge made, for instance, over the Post Office wires in this country as to be beyond all reasonable comparison. Their expenses in 1895 under all heads were £67,820, exceeding by £2,981 those of 1894 After deducting these expenses, the interim dividend paid, and the amount placed to reserve, the directors were enabled to recommend a final dividend and bonus making a total distribution for the year of 10 per cent.

Major-General G. B. Tremenheere seconded the motion, and the report was unanimously adopted.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held on April 29 at Winchester House, the Marquis of Tweeddale presiding.

The **Chairman,** in proposing the adoption of the report and the payment of a dividend of 2s. 6d. a share and a bonus of 4s. a share, making, with previous distributions, 7 per cent. for the year, stated that the gross receipts for the half-year to December 31 last had been £311,582. or an increase of 50,260 over those of the corresponding period of 1894. This increase was mainly due to the exceptionally heavy traffic exchanged with Western Australia in connection with the gold-mining industry, which had so largely developed in that colony. All gold-mining, however, being more or less speculative, they must not reckon upon a continuance of these abnormal conditions. The working expenses of the half-year had been £84,044, or a decrease of £5,696, owing to the cost of cable repairs having been much lighter during the past half-year than during the same period of 1894. Comparing the figures of the whole year, the gross receipts for 1895 had been £575,722 (the largest amount they had ever earned), being an increase over the receipts of the year 1894 of £66 719. The working expenses for the same period exhibited an increase of £9,263, but this was accounted for by the cable repairs being unusually heavy during the first half of 1895, while several exceptional items also came into last year's accounts The fire insurance fund had been credited with £20,000 from the revenue account, thus increasing it to £26,159, which must be still further added to. After paying the dividend and bonus recommended, there

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was a balance of £129,329, which had been carried to the general reserve fund, which now stood at £561,546, after debiting the fund with the balance of the cost of the alternative Singapore-Hongkong cable and the cable renewals effected during the half-year. At present all the cables were in good working order, but he believed that that was the first occasion on which this statement had been made. The directors had decided to revise the local tariffs on July 1 by placing them on a more uniform and satisfactory footing. These reductions were expected to result in a considerable loss of revenue at first—possibly at the rate of £40,000 per annum—but it was hoped that the loss might eventually be recouped by growth of traffic.

The motion was seconded by **Mr. F. A. Bevan** and carried unanimously.

Great regret was expressed at the illness of Sir John Pender, the chairman of the Company.

HASTINGS ELECTRIC LIGHT COMPANY.

The annual meeting of the Hastings Electric Light Company was held at the Queen's Hotel, Hastings, on April 24. The directors present were Messrs. F. A. Langham (chairman), F. Noakes, F. J. Parsons, J. Reeves, sen., J. Woodhams, and A. L. Ward, and there was a good attendance of shareholders.

The **Chairman**, in moving the adoption of the report, expressed regret at the character of the report, but said there were good prospects. Their increase on the receipts of lighting amounted to the sum of £1,302. At the end of 1893 the lamps were equal to 8 c.p., and they had 5,446 lights. In 1894 they had 6,434, and last year they increased to 8,199. The increase on the lighting revenue was £1 302, and the cost of production in 1894 was £2,234. 5s. 2d.; and in 1895, £3 226. 5s. 3d., an increase of £892. 0s 1d. The sum paid for distribution of electricity in 1894 was £219. 4s. 11d., whilst last year it was only £82 14s. 5d., a decrease of £126. 10s. 6d. The cost of public lamps came to £327. 19s 11d., as against £431 2s. 9d., or a saving of £103 2s. 10d. The rates and taxes, he was sorry to say, were £59. 16s. 10d higher than in 1894. The management expenses were £591 1s 2d., as compared with £740. 18s. 10d , a decrease of £149. 17s 8d. The law charges were £137. 9s. 2d. more last year than in 1894, but he would explain that later, whilst the special charges showed an increase of £354. 17s. 9d. This left them a net increase of income of £237. 7s. 2d. This included the bad debts and law charges, the latter of which were a heavy amount this year, caused by the arrangement for the new premises and additional warehouses. They could not carry on the business of the electric lighting without the sanction of the ground landlords of the Cornwallis Estate, who wanted them to surrender their old lease and take a new one, and other things Of course, these charges would not occur again, nor would the £355. 18s. 3d. for bad debts. He was not sure that the new system of the sale of current benefited either the Company or the consumers. Large consumers might derive benefit, but to get the full advantage electricity should be as liberally used as gas. To use both meant that they would very probably pay more for both, but the more electricity they used the cheaper it got. He was sorry that the public lighting had been a great burden to the Company, and had ended in an absolute loss. They had fulfilled their contract to light the Front at a very low sum, and the loss on this account, coupled with the expenses necessary for lighting, meant quite sufficient to pay a dividend. Until they could get rid of the contract, or get better terms, the Company could not be in a flourishing condition. The directors were considering what price they should charge the Corporation for the light. If they did not wish to continue, the Corporation was bound to buy the fittings and wires at a valuation, so that the shareholders would get some of their money back. They had enough private incandescent lighting to supply to keep them busy.

Mr. H. G. Shorter seconded the motion, and the report was unanimously adopted.

Messrs. Noakes and Parsons were re-elected directors.

CONTINENTAL METROPOLITAN TRAMWAYS COMPANY, LIMITED.

The ordinary general meeting of the shareholders was held at the Cannon-street Hotel on April 24, Mr. B. H. Van Tromp presiding.

The **Chairman** stated that they had expressed their willingness to adopt mechanical traction in Paris in return for an extension of the concession giving the company 30 years' longer life, but it was evident that the town of Paris was not willing to entertain such a proposal. That being so, they had asked the town for a subsidy of £16,000 a year for 14 years to get over the difficulty of amortisation. If this proposal were accepted, they felt that they would be justified in taking the necessary steps for making the change in the method of traction.

The report was unanimously adopted.

ELMORE'S GERMAN AND AUSTRO HUNGARIAN METAL COMPANY, LIMITED.

The fifth annual meeting was held on Monday at Winchester House, Mr. John M'Farlan presiding.

The **Chairman**, in moving the adoption of the report, stated that the accounts showed a satisfactory state of affairs. The trading account showed a considerable improvement over that of 1894. The sales were more than double, while the amount spent on manufacturing, purchases, and wages, after deducting copper, was not very much larger than in 1894. Although the improvement in sales was large, it was not so great as was expected, but they had had serious and unexpected difficulties to meet. In 1893 the amount of work done was of the value of £3,194; in 1894, £8,130; and in 1895, £17,025 As to the present year, the sales up to the 19th April had been 59¾ tons, of the value of £5,648, as compared with 40¾ tons, of the value of £3,706, last year. The Board admitted that from a shareholder's point of view progress had been slow and disappointments grievous, but these were always encountered in the working out of any new invention. Now that every technical difficulty in working had been overcome it was felt essential that the business should be conducted on a large scale, and to carry out the extensions considered necessary £25,000 would be required.

Mr. John Heal seconded the motion, which was carried unanimously.

The retiring director (Mr. Heal) and the auditors (Messrs. Cooper Bros. and Co) were re-elected.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Prague (Austria).—Tenders are wanted by June 1 for an electric lighting central station for the city of Prague Application should be made to the Stadrath, Prague.

Peneranda de Bracamonte.—Tenders for electric lighting of the town for a period of 15 years may be sent to the authorities at the Casa Consistoria, Peneranda de Bracamonte, Spain, by May 28.

Bruges.—Tenders are wanted by May 13 for the supply and erection of an electric water-level indicator for the River Lys. Particulars from Le Gouvernement Provincial, Bruges, Belgium.

Stralsund (Germany).—Tenders are invited for installing the electric light on a steamer. Particulars for 1·50 marks (1s. 6d.) from the Werftbureau, Konigl. Wasser-Bauinspection, Stralsund.

Chapelle-lez-Herlaimont.—Tenders are wanted by May 15 for erecting three lightning conductors on the Hôtel Communal. Address, M. le Bourgmestre, Chappelle-lez-Herlaimont, Belgium.

Spezzia (Italy).—Tenders are wanted by May 11 by the Torpedo and Electric Department at the Spezzia Arsenal and Dockyard for the supply of a quantity of copper and brass in wire sheets, and nails, etc.

Frankfort-on-the-Main.—Tenders are wanted by May 9 for the supply of telegraph posts for the Government railways. Address, Konigl. Eisenbahn-Telegrapheninspection, Frankfurt-a-M., Germany.

Oldham.—Tenders are wanted by May 12 for an engine and dynamo of 360 h.p. from makers only who have previously constructed dynamos of that size. Particulars of Mr. A. Andrew, Gas and Water Offices, Oldham.

Hammersmith (London).—The Vestry want tenders by May 27 for (*a*) high and low pressure cables, (*b*) arc lamps and posts, (*c*) transformers, (*d*) an overhead travelling crane. Particulars from Mr. A. H. Preece, 39, Victoria-street, Westminster, on a deposit of two guineas.

Paris.—Tenders will be received by the Prefect of the Seine at the Paris Tribunal de Commerce on May 23 for the installation and working for 10 years of the electric light at the Hospice de Brévannes. The estimate is about £5,533, and the maximum annual payment 27,000f. (about £108).

Bray (Ireland).—The Town Council want tenders by May 17 for (1) a steam alternator, 75 kilowatts; (2) a Lancashire boiler, 200 h.p.; (3) economiser and feed-pump; (4) a vertical high-speed engine. Specifications, etc., can be obtained from Mr. P. MacDonnell, town clerk's office, Town Hall, Bray, on deposit of two guineas.

Lisbon.—Tenders are wanted by the Royal Portuguese Railway Company for the supply of articles and material necessary for the upkeep of their electric lighting. Tenders must be sent to the chief engineer, at the company's stores at Santa Apolonia Station, Lisbon, by May 6, and particulars can be obtained there, or at the company's Paris offices, Rue de Châteaudun 28.

Kingston-upon-Thames.—Tenders are required by the Corporation for the supply of coal for the electric works for the year ending July 1, 1897. Conditions and forms of tender can be obtained at the town clerk's office, Clattern House, Kingston-upon-Thames. Sealed tenders, endorsed "Coal," to be delivered by 7th inst. Mr. Harold A. Winser, town clerk.

Wakefield.—Tenders are invited for the construction and erection of Contract No. 2, electric lighting buildings, etc., at Calder Vale, Wakefield, for the Council. Plans and specification may be seen and bill of quantities and form of tender obtained (on payment of £1. 1s., to be returned on receipt of bona fide tender) at the office of Mr. R. Porter, city surveyor, Town Hall, Wakefield. Tenders for the whole of the works, or for the works comprised in each separate trade, addressed to the Town Clerk, Town Hall, Wakefield, to be delivered by 13th inst., endorsed "Tender for Contract No. 2."

St. Helier (Jersey).—Persons wishing to establish a lighting station in the locality for the purpose of supplying electric, gas, or other forms of light, for both public and private use, are requested to communicate with Mr. P. Baudains, constable, Town Hall, St. Helier, Jersey. All such preliminary communications

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are to state (1) form of light—*i.e.*, whether electric, gas, etc.; (2) in the case of electric light, what methods of generation and distribution would be adopted; (3) proportionate price for public purposes and private lighting; (4) general conditions under which tenders would be made. All necessary information will be supplied on application.

Coventry.—The Electric Lighting Committee require tenders for the supply and erection of the following plant: (Section A) boiler-house plant—boilers and fittings, mechanical stokers and economiser, feed pump, etc.; (Section B) engine-house plant—steam-engine, alternator, oil filter, fittings, etc., steam, exhaust, feed blow-off, sundry pipes, valves, etc. Tenderers are at liberty to tender for either section but not for part of a section The ground plan of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation Ormond House, Great Trinity-lane, London, E.C., on and after 24th inst. on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. Lewis Beard, town clerk, St. Mary's Hall, Coventry, and delivered by May 12

Shooter's Hill (London).—Tenders are wanted by May 6 for the provision and fixing of electric bells, telephones, fire alarms, etc., at the Brook Fever Hospital, Shooter's Hill, S.E., for the Metropolitan Asylums Board. Copies of the specification form of tender, conditions of contract, and of the drawing, which have been prepared by Prof. Kennedy, LL D., F.R S., of 14, Old Queen-street Westminster, S.W., can be obtained at the chief offices of the Board on and after 16th inst. upon depositing gold or Bank of England note to the value of £5 (which will be returned only to those who send in a bona fide tender in accordance with the terms of this advertisement, and who return the drawing, specification, and conditions of contract). Tenders, which will only be received on the lithographed form supplied by the Board, must be sealed and endorsed "Tender for Electric Bells, Telephones, etc, Brook Hospital," and must be delivered at the Chief Offices, Norfolk House Norfolk-street, W.C., by 2 p m. on May 6. Unless the tender be accompanied by the specification, conditions of contract, and the drawing it will not be considered.

RESULTS OF TENDERS.

Birmingham.—The Birmingham Electric Supply Company, Limited, have got the contract for wiring and fitting the new general hospital.

Edinburgh.—The tender of Messrs. Lowden Bros, at £188, for wiring the City Chambers for the electric light, for the Corporation, has been accepted.

Elberfeld.—For electric lighting installations at the Elberfeld and Barmen stations of the Prussian State Railways on April 20, the lowest tenders were as follows: for the whole installation at Elberfeld, including the steam-engines, the Helios Aktien-Gesellschaft, Köln-Ehrenfeld, 86,920 marks; for ditto at Barmen, the Elektricitäts Aktien-Gesells. vorm. W. Lahmeyer und Cie., Frankfurt-a-M., 61,204 marks. Twenty-four firms tendered, but some of these were for the engines only. No English firm tendered.

London, N.—The following tenders were received for electric lighting at the Northern Polytechnic Institute, Islington:

A. Fearnhead	£1,027
Strode and Co.	419
Crompton and Co.	407
Faraday and Son	340
Vaughan and Brown	266
Wenham and Waters	245
Russell and Lennard (accepted)	219

Bedford.—For the construction in various positions in the borough of five electric light underground sub-stations, for the Bedford Urban Sanitary Authority, the following tenders were received:

T. H. Coleman (accepted)	£235 0 0
G. E. Fathers	272 10 0
T. Laughton	295 0 0
J. P. White	325 0 0

All of Bedford.

Bedford.—The Electric Light Committee received the following tenders for the supply and erection of the following plant: (Section A) one 240 b.h p. double-acting compound enclosed engine, (B) one 150-unit alternator with stationary armature:

Engine and alternator.

S. Z. de Ferranti	£2,350
Brush Electrical Engineering Company	2,253
D. Stewart and Co.	2,195

Alternator only.

Siemens Bros. and Co.	1,250
Fowler and Co., Leeds	1,090
Crompton and Co.	980
Mather and Platt	930
Manchester Edison-Swan Company	928
Electrical Construction Company	903
Johnson and Phillips	850
Easton, Anderson, and Goolden (accepted)	654

Engine only.

Belliss and Co.	1,050
Sissons and Co.	790
W. H. Allen, Son, and Co. (accepted)	700

Cardiff.—The following tenders were received by the Corporation for the construction, supply, delivery, and fixing of two boilers of the dry-back marine or water-tube type, each to evaporate about 6,000lb. of water per hour, and one 250 to 300 kilowatt direct-driven steam alternator:

Engine and alternator.

Electrical Construction Company, Peache engine, E.C.C. alternator, 250 k.w., speed 350	£2,493 0 0
Brush Company, Raworth engine, Mordey alternator, 300 k.w., speed 266	2,668 0 0
Crompton and Co., Peache engine, Crompton-Brunton alternator, 300 k.w.	2,770 0 0
Electrical Construction Company, Pollitt and Wigzell engine, E.C.C. alternator, 300 k.w., speed 127	2,970 0 0
Crompton and Co., Willans engine, Crompton-Brunton alternator, 300 k.w.	3,015 0 0
Crompton and Co., Belliss engine, Crompton-Brunton alternator, 300 k.w.	3,051 0 0
Ferranti and Co., Ferranti engine, flywheel alternator, 300 k.w., speed 200 (accepted)	3,250 0 0
Johnson and Phillips, Belliss engine, J. and P. alternator, 300 k.w., speed 300	3,350 0 0
Siemens Bros., Belliss engine, Siemens alternator, 300 k.w., speed 300	3,360 0 0
Electrical Construction Company, Belliss engine, E.C.C. alternator, 300 k.w., speed 300	3,407 0 0
Ferranti and Co., Belliss engine, flywheel alternator, 300 k.w., speed 350	3,500 0 0
Siemens Bros., Willans engine, Siemens alternator, 300 k.w., speed 267	3,740 0 0
Easton, Anderson, and Goolden, Corliss engine, patent alternator, 300 k.w., speed 120	4,100 0 0

Boilers.

E Danks, Birmingham, dry-back marine boiler (accepted)	767 10 0
J. Thompson, Wolverhampton, Economic	890 0 0
Fraser and Sons, Limited, London, dry-back marine	974 0 0
G. Sinclair, Leith, dry-back marine	990 0 0
Davey, Paxman, and Co., Economic	998 0 0
Crompton and Co., Economic	1,028 0 0
Tinkers, Limited, dry-back marine	1,060 0 0
Fleming and Fergusson, Clyde water-tube patent	1,079 0 0
Lindsay, Burnet, and Co., dry-back marine	1,095 0 0
Hawkesley, Wild, and Co., dry-back marine	1,100 0 0
Babcock and Wilcox, water-tube	1,100 0 0
Fleming and Fergusson, dry-back marine	1,110 0 0
Abbott and Co., dry-back marine	1,150 0 0
Electric Construction Company, dry-back marine	1,155 0 0
Hornsby and Co., dry-back marine	1,400 0 0
J. Brown and Co., Scotch marine, with patent draught, etc.	3,700 0 0

BUSINESS NOTES.

Leith.—The ratepayers want to amalgamate with Edinburgh so as to share in the electric light.

Cheltenham.—The estimate for street electric lighting during the ensuing year amounts to £280.

Hull.—The borough engineer has been instructed to report on the various systems of electric traction in use.

Morley.—The Corporation have applied to the Board of Trade for a license for an installation of electric light.

Hampstead (London).—In order to save time, the Electric Lighting Committee is to report on the tenders received for a new alternator.

Dover.—The Corporation Tramways Order has been advertised prior to its being introduced in a confirmation Bill. Electric or cable power will be used.

Edinburgh.—The Electric Lighting Committee have resolved to reduce the charge per unit to 5d. from May 15 next, to fix the rate for public lamps at £18 each per annum, and to discontinue meter rates.

The Great Wheel.—Messrs. Foote and Milne, electrical engineers, have carried out a novel form of advertisement at Earl's Court by illuminating great letters on the rims of the wheel with electric lamps.

Catalogue.—We have received an interesting catalogue of electric light fittings from Messrs. F. and C. Osler, 100, Oxford-street, W. Owing to want of space, we are compelled to hold over our notice till next week.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending April 26 amounted to £1,168, as compared with £1,121 in the corresponding week of the previous year, being an increase of £471.

Eastern Extension Telegraph Company.—The *Times* correspondent at Simla says that the cotton trade between Bombay and Japan, which is yearly growing in importance, is greatly handicapped by the high rates for cablegrams charged by the Eastern Extension Company.

Brighouse.—Mr. Brook, the owner of the plant at present supplying the electric light in the borough, has offered, through Mr. Furniss, solicitor, to sell the plant to the Corporation, and a sub-committee of the Gas Committee has been appointed to obtain the terms and conditions of sale.

Liverpool.—A Board of Trade enquiry has been held into the application of the Liverpool District Electric Lighting Company for an order empowering them to supply electricity in the districts of

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Garston and Much Woolton, the Urban District Councils of which had no objection to the granting of the order.

Hanley.—At a meeting of the Town Council the General Purposes Committee reported that the British Insulated Wire Company had offered to supply the twin cable, ceiling roses, and other fittings for the two park lodges free of cost, and the committee recommend that this offer be gratefully accepted. The report was adopted.

Tunbridge Wells. — The enlargement of the electric light station has been commenced and the foundations have been got in this week. In view of the approaching Royal visit, the borough electrical engineer is arranging for electric illuminations for the evening in connection with the decorations which are being organised.

City and South London Railway.—The returns for the week ended April 26 were £889, compared with £900 for the corresponding period of last year, being a decrease of £11. The total receipts for the half-year terminating as above were £16,149, compared with £16,119 in the same period of the preceding year, being an increase of £30.

Glasgow.—The members of the sub-committee on mechanical tramway traction have decided before making any report to the Tramways Committee or to the Corporation. and before entering upon consideration of the report by Messrs. Crawford and Young, to visit Coventry, Bristol, and Hamburg, and inspect the electric tramways in these places.

City and South London Railway Bill.—The City and South London Railway Bill was read a second time last Friday, and the committee to which the Bill was referred was instructed to consider whether any provisions can be made for the preservation of the Church of St. Mary Woolnoth without preventing the construction of the railway and station.

Cleckheaton.—At the general meeting of the Co-operative Society a prolonged and animated discussion ensued on the question of lighting up the Central Stores with electricity. The estimated cost of the installation was stated at £800 to £1,200 and 50 votes were recorded in favour of electricity to 51 against. Consequently the proposal was defeated.

Chatham.—At the meeting of the Town Council the Highway and Works Committee reported a complaint from the electric lighting company as to the Corporation workmen having damaged one of their mains. This arose from a complaint by the Corporation that the electric lighting company had taken up the footway without first giving notice. The company, however, pleaded emergency. The surveyor was instructed to enquire into the matter.

Dalkey.—At a meeting of the Town Commissioners a letter was read from Messrs. M'Loughlin and Garland, solicitors, enclosing a copy of counsel's opinion with reference to the electric tramways company and the state of the township roads Counsel advised that proceedings should be taken to compel the company to put the roads and footpaths in order. The Chairman suggested that the consideration of the matter should be postponed, and the suggestion was adopted.

Blackpool.—A Local Government Board enquiry has been held into the application of the Corporation for permission to borrow a sum of £30,000 for electric lighting purposes. It was stated by the electrical engineer that a further extension of the works was urgently need. There was at present a demand for current which could not be supplied, and unless new plant was put down for the summer season the committee in charge of the works would not be able to fulfil its obligations.

Appointments Vacant.—The Shoreditch Vestry require a resident electrical engineer to take charge, under the Vestry's consulting engineers, of the laying of mains and the erection of electrical and steam machinery for central stations, for a minimum period of four months, at a salary of £4 per week. Applications, on forms provided, with copies of two recent testimonials, to be sent to Mr. H. Mansfield Robinson, vestry clerk, Town Hall, Old-street, E.C., by 4 p.m. on 11th inst.

Dublin.—The Pembroke Commissioners have held a special meeting to consider, under the provisions of the Tramways Acts, the Rathmines, Dundrum, and Blackrock district tramways scheme, and having heard what was alleged on behalf of the promoters, they disapproved of the project, on the ground that the statutory requirements of the Tramways Acts have not been complied with, that the deposited plans are defective, and that the company proposing to work the line have practically no capital subscribed.

Western and Brazilian Telegraph Company.—After placing £3,000 to the reserve fund and £7,952 to the debenture redemption fund. the directors propose a balance dividend of 5s. 3d. per share on the ordinary shares, making 3 per cent. for the year ended December 31 last. The preferred ordinary shares are to receive 3s. 9d and the deferred ordinary 1s. 6d. The receipts for the week ending April 24, after deducting 17 per cent. payable to the London Platino-Brazilian Telegraph Company. amounted to £2,648.

Haslingden.—At a special meeting of the Industrial Co-operative Society it was resolved to light the four front shops of the society with electricity. From a statement by the manager (Mr. H. Ashworth) it appeared that the Wholesale Society's engineer estimated that by trebling the consumption of gas in speeding up the present engine sufficient electricity could be generated for the four shops, providing 89 16-c.p. incandescent lights. The installation would cost £470, and there should be a saving of 10 per cent. on the outlay.

Central London Railway Company.—The hearing of the case of the Kensington Woodhouse Park Syndicate *v.* the Central London Railway occupied Mr. Under-Sheriff Burchell and a special jury at the London Sheriff's Court for four days. The claim was for £28,000 as compensation for the compulsory acquirement by the respondents of an estate known as Woodhouse Park, Shepherd's Bush. The jury found a verdict for £4,500, to which 10 per cent. was added for compulsory purchase, making the total compensation £4,950.

Bolton.—The members of the Joint Committee of the Streets and Electricity Committee have under consideration the report prepared by the borough surveyor (Mr. Brockbank) and the former borough electrician (Mr. J. H. Rider, M.I E E.) on the application of electricity (overhead wire system) to the tramways. A deputatation has visited Bristol and Walsall to inspect the systems there in vogue. The deputation were met at Bristol by Mr. Rider, who has commenced his duties as borough electrician at Plymouth, and explained the system on the four miles length, from the old Market-place, Bristol, to Kingswood.

Dewsbury.—A meeting of the governors of the Technical Institute has been held for the purpose of receiving a further report from a committee specially appointed to consider the question of lighting the classrooms, etc., by electricity. The details of the scheme were discussed in committee After discussion, a resolution was passed approving of a sub-committee's scheme of lighting the lecture-theatre, classrooms, and corridors. It was further resolved that a deputation should wait upon the Lighting Committee of the Dewsbury Corporation to see if they could arrange terms, etc. a report to be made to a meeting of the governors, to be held at an early date.

Eccles.—The work of putting down the electric light installation at the new Co-operative Stores is progressing rapidly. A main switchboard of the latest and most improved type, with lightning-arresters and measuring instruments will be placed in the engine-room, and electric bell circuit for signalling purposes established with the new premises. About 200 yards of main cable, carried overhead on suitable poles, will be required to convey the current to a main distribution-board on the ground floor. The dynamo has a capacity of about 250 16-c.p. incandescent lamps. The elevator in the new premises will also be worked by electricity from the same plant.

The City and Waterloo Railway.—This railway has made such advance that preparations are in progress for commencing the underground station at the City end of the line. From the river, the tunnels up Queen Victoria-street as far as Cannon street would have been commenced and would probably have been completed but for the requirements of the District Railway that the new line passing under their property should be excavated by the compressed-air system, so as to obviate any possible disturbance of the District Railway. They were empowered to do this by the Act of Parliament authorising the new enterprise. It is reckoned that this necessity has delayed the work by about three months.

New Companies.—The Telescriptor Syndicate, Limited, has been registered to enter into an agreement with B. Hoffmann for the acquisition of certain patents relating to improvements in telegraphic apparatus and typewriting machines, and to develop and turn to account the same. Registered office, 11, Victoria-street, S W. The International Improved Electric Company, Limited, has been formed to acquire the benefit of certain inventions for improved electric incandescent lamps and certain registered models, designs, and for a process for the manufacture of the same, and the letters patent, and to develop and turn to account the same. Registered office, 1, Arundel street, Strand.

Baker-street and Waterloo Railway.—The opposition that has been threatened to the Bill promoted by the Baker-street and Waterloo Electric Railway Company has been withdrawn. By this Bill, which has now passed unopposed through the Commons, powers are granted to the company to construct a short extension of their authorised line so as to connect with the London terminal station of the Manchester, Sheffield, and Lincolnshire Railway Company. The additional share and loan capital granted is £100,000. The Bill also authorises the construction of this railway in three separate sections, each section having a distinct capital. An extension of time is also granted until March, 1901, within which to construct this railway.

Coventry.—There is a deficiency of £1,112 on the year's working of the electric light undertaking ; but at a meeting of the City Council Mr. James remarked that the works were already nearly paying running expenses. The Council might, he thought, look upon the undertaking as being very satisfactory ; they could not expect in the first year to make provision for a sinking fund and interest on capital. They might look, however, to the department paying the whole of its expenses in a short time. The library is now lighted throughout by electricity. The specifications were drawn by Mr. Ram, the city electrician, and the work carried out by the Coventry Electrical Engineering Company, Limited, under the supervision of Mr. Eaves. The distribution-board system is used.

Kingston.—The Maldens and Coombe District Council are prepared to consider favourably the application of the Corporation to supply electricity in Coombe if terms satisfactory to the District Council can be arranged. Negotiations are still proceeding. At the meeting of the Town Council it was reported that a letter had been received asking what arrangements could be made for laying a main from the borough to Warren House, and it was agreed to suggest an interview on the matter. Replying to Councillor Brown, who again asked how much longer the services of Mr. Preece were to be retained as consulting engineer Councillor Collings repeated the answer which he gave at the last meeting, that as soon as the capital expenditure on which Mr. Preece was

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engaged to advise had been completed his connection with the Corporation would terminate.

Slide Rules.—We have received a new compound slide rule, designed by Mr. C. N. Pickworth, Whit Sch., the author of the book called "The Slide Rule." This new rule is specially arranged for computing quickly the horse-power of gas and oil engines. It can also be used for steam-engine calculations, and for the inverse operation of determining the dimensions of an engine for a given power and speed. The other operations which can be carried out on the rule are the determination of piston speed; the speed ratios of pulleys, gear wheels, etc.; the circumferential speed of pulleys; the velocity of bells, ropes, etc; and the simple operation of finding the area of circles, etc. This rule, which can be obtained direct from the inventor, at Fallowfield, Manchester, at a net price of 5s., should find a ready sale.

Leeds.—At a meeting of the Parliamentary Committee the town clerk reported that the Mayor (the Right Hon. W. L. Jackson) had given notice in Parliament of a motion to suspend the standing order which prohibits a committee of Parliament giving power to a corporation working their own tramways. If this motion be carried, and the Committee of the House of Commons agree to the insertion in the Leeds Tramways Bill of a clause giving the Corporation the necessary power to work the tramways, the Bill will then have to go back to the House of Lords that the same subject may be dealt with there. The Corporation at present do not possess full powers for working the tramways of the city. All they are now authorised to do is to work the tramways until such time as some company or other shall lease them in accordance with the Corporation's terms and conditions.

New Companies and Electricity.—The following companies just registered take power to construct and work tram and rail roads, telegraph and telephone systems, electric works, etc., or to carry on the business of electrical engineers: the Goldfields of Venezuela, Limited, 53, Coleman street, E.C.; the Sanitary Supply Corporation, Limited, 52, Queen Victoria-street; Ransomes and Rapier, 32, Victoria-street, S.W.; Red Lion Chalk and Whiting Company, Limited, 16 Mark-lane, E.C.; Kamfersdam Mines, Limited, 18, Austinfriars, E.C.; South Zambesi Development Company, Limited, 3, Abchurch-lane; New Alburnia Gold Mining Company, Limited, Finsbury House, Blomfield-street, E.C.; Blocks 35, 37, and 39 Hampton Plains, Limited, 9, St. Mildred's-court, E.C.; Coolgardie Austral Gold Mining Proprietary, Limited, Winchester House, E.C.

Belfast.—At a meeting of the Electric Committee the engineer submitted his report upon the sites available for a generating station on a large scale, including two or three pieces of Corporation property, one of which, abutting on the river, is, we understand, likely to be selected, but the committee came to no definite resolution in the matter pending the granting of authority by the Council for the realisation of the committee's scheme. It is notified in the parliamentary papers issued on Saturday last that the petition presented by the Corporation against the Bill promoted by the Belfast Street Tramways Company has been withdrawn. The inference to be drawn from this is that the company has accepted the amendments submitted to them by the town clerk or so much of them as will meet the requirements of the Corporation. The Bill will now go forward as an unopposed measure.

Aberdeen.—At a meeting of the Electric Lighting Committee a report was submitted from Mr. Smith and Mr. Blackman, the electrical engineer, with reference to the proposed extension of the station in Cotton-street in order to provide additional electric light to meet the demand of customers. The proposed extension also provides for the erection of two new boilers. The total cost of the work is estimated at between £7,000 and £8 000. Negotiations are in progress between the Great North of Scotland Railway Company and the Town Council for the electric lighting of the Palace Hotel by current supplied from the Corporation mains. At present the railway company generate the current by means of their own plant. A committee of the Royal Horticultural Society of Aberdeen has been appointed to report on the electric lighting of the annual show, which will be held in the grounds of Gordon's College.

Southport.—Colonel A. G. Durnford has conducted an enquiry on behalf of the Local Government Board in response to an application by the Corporation for sanction to borrow £4,000 for electric lighting purposes. The Town Clerk (Mr. J. Davies Williams) said the Corporation had already expended £42,822 in the construction of an electricity works and in laying down the high-tension cables, transformers, and radiating low-tension mains, and in making the service connections. They now served by this means 150 private consumers with 11,500 lamps. The electric energy at Crowlands station was beyond this number of lamps, and the major portion of the £4,000 was to be expended in making that power practically available to further customers. They calculated that they would be able to serve another 100 customers without expending more than about £3,400, which would mean 7,500 lamps, or a total of 19,000. The enquiry then closed, and the inspector afterwards visited the electricity works at Crowlands.

Maidstone.—Once again Mr. Cox has got his own way, and unless his resolution is rescinded the harassed question of the provisional order will rest undisturbed for 12 months. But it would not be like the Corporation to put away such an interesting ninepin, and more than likely Mr. Cox's resolution will be rescinded before many weeks have passed, and the whole question will be reopened. At the last meeting of the Council Alderman Ellis moved that the terms offered by Mr. King for the purchase of the order should be accepted. Mr. Cox moved an amendment that the matter should be deferred for 12 months because he had been informed that there would be some startling results in the electrical world during that period. During the course of the discussion a long letter was read from Mr. Leavey, the present Mayor of Chatham, who is a ratepayer of Maidstone, urging the Council to lay down a suitable plant, and saying that he personally would be very glad to sign an agreement for the light at £120 per annum. In the end Mr. Cox's amendment was carried by 12 votes to 9.

Bristol.—At a meeting of the Sanitary Committee Mr. Yabbicom, the city engineer, presented his report on the application of the National Telephone Company, Limited, to lay wires underneath the public streets. Information was given as to how various corporations in the country had dealt with similar applications. He reported that Manchester appeared to have made good terms with the company, the latter agreeing to pay the Corporation 5s. per annum for each subscriber to the telephone exchange on a minimum of 3,000 subscribers, and 5s. for each subscriber over that number; an annual payment of 5s. or 10s. for each manhole, according to size, and 5s. per annum for each trunk wire placed in the tubes. To guard against these payments being charged to the subscribers of the company, the Corporation had inserted a clause which prohibited any increase of the annual subscriptions being made without the consent of the Corporation. It was agreed that the committee should recommend that the application should be granted, subject to charges of 3s. per subscriber, 20s for each manhole, and 5s. for each trunk wire.

Chelmsford.—The demand for the electric light by private consumers is increasing every week. The foundations for the new electric lighting station for the town have been laid, and plant will be put down in the station for the supply of 10,000 lamps. During the last quarter the number of private lamps in use has been increased by 350. The total number of such lights now installed is 3,800, and the company have orders on their books for at least 500 more. At the meeting of the Town Council the Lighting Committee reported that the town lighting contract with Messrs. Crompton and Co. having expired they had renewed the same for another five years, the terms—£22. 10s. annually for arc lamps and £2. 6s. 10d. for each incandescent lamp—being as previously. They further considered the company's offer to sell the proposed new station as a going concern, the entire plant and goodwill, together with the firm's provisional order. The price asked was £34,828, but the committee were unable to come to any conclusion until they had consulted some expert. The matter will now be considered by the whole Council.

Grimsby.—At a meeting of the Electric Lighting Committee Alderman Dobson said that the sub-committee recommended that some of the members of the committee should visit other towns where the electric light was being used with success, and then employ an expert and get his advice. Mr. Alward proposed that the recommendation of the committee to the Council be that they be empowered to proceed with the electric lighting scheme. He would suggest that they advertise for the best scheme for the lighting of Grimsby with the electric light, and that a visit be made to a few towns where the light was used with success. He would not recommend them to employ an expert. The provisional order expires in July next, and the Town Clerk said that if the committee would wait till the next session of Parliament, which would be in November, and then apply for an extension of the order, he did not think that there would be any danger of a private company stepping in before them. Mr. Alward then withdrew his resolution, there being no seconder. It was unanimously agreed to recommend to the Council that, as soon as the provisional order lapses, they apply for a renewal; and also that the sub-committee be empowered to visit other towns for information in the meantime.

London Lighting Extensions.—The London County Council have sanctioned notices of extensions from the following: Metropolitan Electric Supply Company, to lay mains in Boundary-road, St. John's Wood-park, Ordnance-road, Acacia-road, Henstridge villas and place, Norfolk-road, Woronzow road, Townshend road and cottages, Upper York-place, Eaton-terrace, St. John's Wood-terrace, Henry-street, Charles-street, John-street, Frederick-street, Barrow Hill-road, Avenue-road, Titchfield-road, Wells-road, Albert-road, Macclesfield Bridge, Outer Circle Regent's Park, Mortimer-road, Greville road and place, Belgrave road and gardens, Clifton hill, Carlton-hill, Blenheim-terrace, Abbey-road, Marlborough road, place, and hill, Loudoun-road, Finchley road and place, Langford place, Waverley-place, Queen's road and terrace; St. James and Pall Mall Electric Light Company, to lay mains in and across Jermyn-street; Charing Cross and Strand Electricity Supply Corporation, to lay mains on both sides of and across Buckingham-street and across Duke-street, and to construct two service boxes; County of London and Brush Provincial Electric Lighting Company, to lay low-tension mains in Spencer-street, Clerkenwell; Notting Hill Electric Lighting Company, to lay mains in Victoria-gardens, Ladbroke road, grove, and terrace, Holland-park-avenue, in a small portion of Holland-park, in Addison-road, in Palace-gardens-terrace, Brunswick-gardens, Berkeley-gardens, Silver-street, Sheffield-terrace, Campden House-road, and Gloucester-walk; House-to-House Electric Light Supply Company, to lay low-tension mains in Gilston-road and Fulham-road.

Dundee.—Last week about 50 members of the Institute of Engineers visited the telephone exchange, Panmure-street. They were first shown the new switchboard, the working of which was explained by Mr. Brown, the company's manager, and then the wire-testing apartment was visited, and a number of the members ascended to the roof and inspected the apparatus where

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the 900 wires in connection with this exchange converge. The Gas Committee of the Town Council have just received the Board of Trade report with reference to the breakdown at the electric lighting station on January 21 last, owing to the explosion of a cast-iron steam-pipe. Mr. A. Watt, the Board of Trade engineer surveyor-in-chief, reported that the explosion was due to the expansion and contraction of the main steam-pipe, causing undue strain to be put on the cast-iron bend. There was also considerable vibration of the pipes, and the metal was of a spongy nature. After describing the machinery at the electric station, the engineer stated that the main steam-pipe was well supplied with steam-traps, and as the engine had been working for about four hours previous to the explosion it was not probable that there could be an accumulation of water in the pipes to cause the fracture. Mr. Peter Sampson, assistant secretary of the Marine Department of the Board of Trade, after considering the engineer's report, added that the arrangement of the steam-pipes appeared to have been such that any variations in the length of the main pipe due to its contraction or expansion would result in producing severe stresses at the part where the fracture occurred, and, as the metal appeared to have been of a spongy nature, it was not surprising that the explosion resulted.

Bray (Wicklow).—At a special meeting of the Township Commissioners, the town clerk read letters from Mrs. Stoney, Mrs. Quaine, and Captain Ffrench MacDermott objecting to the constructing of an electric tramway along the Esplanade road. A memorial signed by 200 residents in favour of the scheme was also read. A deputation from the promoters of the electric tramway scheme, consisting of Mr. Isaac Molloy, solicitor, Mr. Ryan, C.E., and Mr. Porte, C.E., was in attendance Mr. Molloy explained the scheme, and said the promoters were willing to give the Commissioners every satisfaction. Mr. Ryan stated it was proposed to lay a double line on the Esplanade road and a single line through the main street. It would be a 3ft. 6in. gauge. The Chairman asked Mr. Ryan if the Commissioners decided to make an underground system a *sine quâ non*, would the company be prepared to adopt it. Mr. Ryan said he thought not, as the underground system would be too expensive. The Chairman: Then if we don't agree to the overhead system the whole matter falls to the ground The deputation then withdrew. The Chairman said the question required serious consideration. The company had come to them on April 26 and told them they would require their decision before May 1. He wished to say that he was not prepared to give up to any company for all time rights over the streets of Bray. Therefore he considered the Board would be acting wisely if they did what had been done by the Corporation with reference to the proposed electric tramways for Dublin, and postpone the matter for some time—say, six or twelve months. Up to the present the scheme had not been sufficiently considered, and, as suggested by Mr. Clifton, they ought to get the opinion of the ratepayers on the question. Sir Rowland Fanning proposed that the further consideration of the scheme be postponed for six months. Mr. Condron seconded the motion, and it was adopted.

Lambeth.—At the last meeting of the Vestry there was a big batch of amendments on the agenda in connection with the provisional order question. The first of these required that the order should be put up to public tender, "and such tenders be reported on by a committee of two from each ward, appointed for the purpose." This was lost. The next amendment came from Mr. Iremonger, who proposed that a clause be inserted in the transfer securing due enforcement of Mr. Sax's chief conditions, with this important addition: "That the order be not disposed of, by sale or otherwise, without the consent of the Vestry being first obtained thereto." Mr. Woodward seconded the amendment, which, on a show of hands, was adopted. Mr. Rogers next submitted an amendment requiring the holder of the order to pay to the Vestry "all profits above 5 per cent., to form a fund with which the undertaking may be purchased by the Vestry in the interests of the ratepayers." This was seconded by Mr. Chalton Hubbard, but was on a division rejected by 50 to 20 votes. Mr. Bennetts moved that the report be referred back, with instructions to the committee to consider Mr. Offor's letter, which was read at the last meeting. On a division this amendment was rejected. Mr Stainsby proposed a further amendment, providing that the repurchase price should be at not more than the subscribed capital, "less such amount for depreciation of plant." This was seconded by Mr. Woollacott, but was negatived, as was another proposed by Mr. Corbin and seconded by Mr. Cooper. Mr. Price moved that the report be referred back, with instruction to the committee to enquire into certain allegations which had been made. Mr. Quick seconded, but this amendment was also rejected. The discussion was continued to the hour when, under the standing orders, the Vestry should adjourn. An endeavour was made to suspend the order and prolong the discussion, but this did not succeed. Thus the debate was further adjourned.

Worcester.—At the City Council meeting Mr. Millington pointed out that the estimates included for the first time the Electricity Committee account. The Council would see that they proposed to wipe off the deficiency of £1,950. On referring to the accounts of the Electricity Committee for 1895, they would find that the deficiency was stated to be £1,443 14s. 4d., but there was an item of £535 which would never occur again. The committee estimated that the amount of the deficiency next year would be reduced to £1,225. He had gone carefully through this estimate of the Electricity Committee, and he disagreed with one or two points During last year £1,092 was spent for coal, yet the committee said they would spend £1,000 this year. It was well known that a great part was used for experimental purposes and matters which would not occur again. During the first quarter of this year they had spent only £100 for coal. At the rate of £1,000 for the year they would have £250 a quarter. He did not see, therefore, how that £1,000 was going to be spent. But the committee said that they did not know what sort of a summer they would get. He thought the estimate excessive, however, on what would be required. The receipts on the sale of the current showed a great increase. There was also included £500 for motors at the waterworks, and the Water Committee had put in their original estimate—£600—in respect of that item. The estimate provided for interest on the sinking fund, and when they took a new concern like that, and the renewals, repairs, etc., into account, he thought the citizens would not be surprised to find that there was some deficiency which would have to be wiped off. They would agree he thought, that it should be wiped off, and enable the Electricity Committee to start with a clear balance-sheet for the next year. He instanced Bristol, where some £6,600 was wiped off in two years, Huddersfield £3,400, Blackpool £278, and Great Yarmouth £766. The course they proposed to adopt was therefore one adopted in other towns of more importance even than Worcester. The estimate was approved.

Islington.—At the meeting of the Vestry to-day (Friday) a report will be received from the Electric Lighting Committee stating that they have considered the Vestry reference of April 17 which directed them to consider and report and also to prepare an estimate of the cost of laying mains and providing the necessary plant for lighting by electricity such other parts of the parish as they may deem advisable. For some months past they have had the question of the advisability of extending the supply of electricity to other parts of the parish beyond the limits of the "compulsory" area under careful consideration, and with a view to arriving at a decision as to the desirability or otherwise of recommending such a course to the Vestry, they directed the electrical engineer to prepare and submit a report and estimate as to the probable cost of extensions in certain of the main thoroughfares outside such area. This report and estimate was, prior to the date of the Vestry reference, duly submitted to and under the consideration of the committee, and they recommend (*a*) that it be referred back to the committee to at once take steps for placing orders for the additional plant mentioned in the report of the electrical engineer, and for the necessary extension of the station to accommodate such plant at an estimated cost of £23,750, so that, if possible, such plant may be available for running during the ensuing winter; (*b*) that conduits and mains be at once laid in the Holloway-road, from the Nag's Head public-house to the Archway Tavern, at an estimated cost of £5,000; (*c*) that conduits and mains be at once laid in the Caledonian-road, at an estimated cost of £9,000, several applications for a supply of current having been received from occupiers in that road, including a requisition for current in the Wharfdale-road and neighbourhood equivalent to 3,000 8 c.p. lamps — referred by the Vestry on February 7, 1896; (*d*) that the consideration of the question of the suggested extensions along the Essex and Camden roads be deferred for the present. [Note.—We publish Mr. Gay's report *in extenso* in another part of the paper. Ed.]

Southampton.—At the meeting of the Town Council the Electric Lighting Committee reported that the town clerk submitted draft agreement with the Electric Lighting and Power Company, Limited, and having carefully considered the same, the committee have resolved that the deputy-chairman and town clerk be requested to see Mr. Manville, and to ascertain from him the terms upon which he would be willing to act as consulting engineer to the Corporation. Mr. Manville wrote stating that he should be happy to act as engineer for carrying out of the works included under his report for a fee of 5 per cent. on the actual contracts let for new works, such to be inclusive of all assistance and particulars required for any enquiries, the preparation of all plans and specifications, advising the committee on tenders received, supervising the carrying out of the works, and certifying payments to contractors—the fee being, in fact, an inclusive fee, covering all expenses except clerk of the works and quantity surveyor, who will be required for buildings only. The committee recommended the Corporation to appoint Mr. Manville as consulting electrical engineer upon the terms mentioned in his letter. They could not consent to a joint appointment in favour of Mr. Manville and Mr. Aldridge, but did not object to Mr. Manville making any personal arrangement with Mr. Aldridge. After correspondence with Messrs. Sharp, Harrison, Turner, and Turner, solicitors to the Southampton Electric Lighting and Power Company, Limited, on the subject of the debenture holders, the committee resolved that the purchase-money of £21,000 should be paid to the company in cash, but that in the event of the Corporation hereafter issuing stock at 2¾ per cent., the company should upon the date of such issue have the option of purchasing such stock to the extension of £5,000 only at par value. Alderman Bone proposed the adoption of the report, stating that Mr. Manville was an eminent electrical engineer, who had successfully carried out works at Portsmouth. When the Corporation agreed to purchase the works it was for £21,000, but there was a question as to compensation to the debenture-holders. It was found that they could not give them the option of taking the stock, and they recommended that the purchase-money should be increased by £100, which would get over the difficulty, and they would take possession almost immediately. Mr. Batchelor seconded the proposition, which was adopted, with the alteration referred to by Alderman Bone.

Kingstown.—Cars have been running between Haddington-road and Kingstown, at five minutes' intervals, testing the electric line to Kingstown and Dalkey, and the action of the cars, with the

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most satisfactory results. The Great Southern and Western Company have now a great many drivers and conductors in their employment who have been trained in their respective duties, and who are now on salary. The line will, it is expected, be shortly opened for the accommodation of the public. The Board of Trade having granted the provisional order applied for by the Corporation. The Electric Lighting Committee reported, at the last meeting of the Commissioners, as follows: "The time having arrived when it becomes desirable to consider what system of electric lighting you will introduce into your township and whether you will exercise the powers conferred by the order or lease them to a company, your committee thought it necessary to secure the services of a consulting electrical engineer of eminence to advise on these matters. The importance of having such advice was enhanced by the fact that arrangements were being made for the reconstruction of the footpaths and the laying in connection with this work of a culvert or conduit for the electrical cable Your committee accordingly entered into communication with some well-known experts, and have arranged with Mr. Manville, of the firm of Kincaid, Waller, and Manville to visit the township and prepare a report on the subjects to which we have alluded. Mr. Manville's fee for this work will be 50 guineas, which will be included in his fees if he should be retained to draw plans and specifications for the lighting of the district and to superintend the execution of the works." The report was adopted. With regard to the tramways, Mr. T. W. Robinson, pursuant to notice, moved, "That in order to prevent any further delay in the opening of the tramway traffic in this township after the inspection by the Board of Trade, we hereby request the tramways company to forthwith enter into the necessary contract or arrangement under Section 2 of the Dublin Southern Districts Tramways Act, 1893, with respect to the user by the company, or the paving and keeping in repair of the part of the roadway within the township upon which the tramways are laid, or with respect to the payment by the company to the Commissioners, as roads authority, of an annual or other sum in relation to such user, paving and keeping in repair the said road." The motion was carried.

Battersea. — The result of the competition for the best method of dealing with a public supply of electricity in Battersea has now been announced. It will be remembered that in September of last year the Battersea Vestry invited competitive schemes for the lighting of the parish by electricity and for the utilisation of the dust destructor in connection therewith. With this object instructions to electrical engineers were prepared, and premiums of £50, £30, and £15 respectively were offered for the best three schemes submitted, it being stipulated that the schemes finally selected should become the absolute property of the Vestry, and the premium of the successful competitor, in the event of his scheme being carried out, to merge into and form part of the commission or remuneration for the supply of the necessary detailed plans, specification, etc., and for the general superintendence of the execution of the works. Each competitor was required to submit with his scheme a report as to the best method of utilising the waste heat from the destructor at the Vestry dust depôt in connection with the supply of electricity and to provide in his report for the following: (1) for lighting a small area—(*a*) the lighting of the main and side roads, and (*b*) the lighting of public and private property; (2) for extending the lighting (*a*) to all main roads and (*b*) to public and private property abutting thereon; (3) for extending the lighting (*a*) to all side roads and (*b*) to public and private property abutting thereon. Full sets of drawings and plans had to be submitted with each scheme and detailed estimates given of the capital outlay involved and of the cost of working, showing what advantage would be likely to accrue to the parish by its adoption and a comparison made with the present cost of lighting the streets by gas. The instructions were issued to 28 applicants, and in response 21 sets of schemes were submitted by December 12. These were opened by the committee on the following day. At this stage the Electric Lighting Committee pursuant to the authority of the Vestry, appointed Mr. Robert Hammond M.I.E.E., as the expert engineer to advise the committee and to report on each of the schemes submitted Mr. Hammond's report was a very lengthy document, and each scheme was carefully analysed on a uniform basis and the estimates dissected in a similar manner, the comments and criticisms of the expert following in the same order. By this arrangement an easy comparison was afforded while the comprehensive tabulated summary gave a succinct account of the whole of the schemes. Mr Hammond's report as to the relative merits of these schemes was fully considered by the committee, and in accordance with his recommendation the premiums last week were allotted by the Vestry as under: first (J), Mr. R. A. Dawbarn, M.I.E.E., on behalf of the Brush Electrical Engineering Company, Limited; second (M), Mr. W. Best, Woodlands-road, Ilford; third (F), Mr. J. Hardie McLean, 45, Broad-street, Oxford. These schemes were referred back to the committee, who have instructions to prepare a scheme for dealing with the electric lighting of the parish and to submit same to Vestry at an early date. The Vestry at their meeting also adopted the recommendations of the Electric Lighting Committee in respect to the lighting of the town hall by electricity, and have decided to put the work in hand at once. Mr. Hammond, who submitted a lengthy report upon the matter, has been appointed as the consulting engineer to carry out the work at a fee representing 5 per cent. upon the capital outlay. It is estimated that the cost of the scheme will be about £3 000. Application will be duly made to the London County Council for a loan of £3,000 for the purpose of defraying the cost. The generating works for the town hall lighting will be erected on the vacant land at the rear of the present buildings.

Electric Lighting Provisional Orders.—The following is a copy of memorandum stating the nature of the proposals contained in the provisional orders included in the Electric Lighting Provisional Orders (No. 1) Bill:—Cowes Electric Lighting Order, 1896: The undertakers under this order are the Cowes District Council. The area of supply is the urban district of Cowes. The order contains provisions that the District Council shall lay down mains in certain specified streets within a period of two years, and it provides for the supply of electrical energy in the remainder of the area on certain specified conditions. The order also contains provisions (1) for the approval by the Board of Trade of the system upon which energy is to be supplied, and the issue by them of regulations for securing the safety of the public, and for ensuring a proper and sufficient supply of energy; (2) for the execution of the necessary works and the breaking up of streets etc., and the alteration of pipes, etc, under streets; (3) for regulating the manner in which energy is to be charged for, and fixing the maximum price to be charged; (4) for the appointment, remuneration, and duties of electric inspectors, and the testing of electric lines and other works, and for holding enquiries by the Board of Trade as to the causes of accidents affecting the public safety; (5) for the supply, use, certifying, inspection, etc., of meters; (6) for the application of moneys received by the undertakers in respect of the undertaking; (7) for the transfer to any company or person of the powers, duties, and liabilities of the District Council under the order by means of a deed to be approved by the Board of Trade, upon such terms and subject to such exceptions and modifications (if any), and for such period as may be specified therein; (8) for the revocation of the order under certain circumstances. Folkestone Electric Lighting Order, 1896: The undertakers are the Corporation of Folkestone. The area of supply is the urban district of Folkestone. The order contains provisions similar to those referred to in the case of the previous order. Gloucester Corporation Electric Supply Order, 1896: The undertakers are the Corporation of Gloucester. The area of supply is the city of Gloucester. The order contains provisions similar to those referred to in the case of the previous orders. Huddersfield Electric Lighting Order, 1896: The undertakers are the Corporation of Huddersfield. The order is to be read in conjunction with the Huddersfield Electric Lighting Order, 1890, and extends the area of supply authorised by that order. King's Lynn Electric Lighting Order, 1896: The undertakers are the Corporation of King's Lynn. The area of supply is the borough of King's Lynn. The order contains provisions similar to those referred to in the case of the Cowes Electric Lighting Order, 1896, above mentioned. Manchester Electric Lighting Order, 1896: The undertakers are the Corporation of Manchester. The order is to be read in conjunction with the Manchester Electric Lighting Order, 1890, and extends the area of supply authorised by that order. City of Wells Corporation Electric Lighting Order, 1896: The undertakers are the Corporation of Wells The area of supply is the city of Wells. The order contains provisions similar to those referred to in the case of the Cowes Electric Lighting Order, 1896, above mentioned. The following is a copy of memorandum stating the nature of the proposals contained in the provisional orders included in the Electric Lighting Provisional Orders (No. 2) Bill:—Colwyn Bay and Colwyn Electric Lighting Order, 1896: The undertakers under this order are the Urban District Council of Colwyn Bay and Colwyn The area of supply is the urban district of Colwyn Bay and Colwyn. The order contains provisions that the District Council shall lay down mains in certain specified streets within a period of two years, and it provides for the supply of electrical energy in the remainder of the area on certain specified conditions. The order also contains provisions similar to those mentioned in No. 1 Bill Devonport Corporation Electric Lighting Order, 1896: The undertakers are the Corporation of Devonport. The area of supply is the county borough of Devonport The order contains provisions similar to those referred to in the case of the previous order. Godalming Electric Lighting Order, 1896: The undertakers are the Corporation of Godalming. The area of supply is the municipal borough of Godalming. The order contains provisions similar to those referred to in the case of the previous orders. Kettering Electric Lighting Order, 1896: The undertakers are the Urban District Council of Kettering. The area of supply is the urban district of Kettering. The order contains provisions similar to those referred to in the case of the previous orders. Kingstown Township Electric Lighting Order, 1896: The undertakers are the Commissioners of the township of Kingstown The area of supply is the township of Kingstown. The order contains provisions similar to those referred to in the case of the previous orders. Middleton Electric Lighting Order, 1896: The undertakers are the Corporation of Middleton. The area of supply is the borough of Middleton. The order contains provisions similar to those referred to in the case of the previous orders.

PROVISIONAL PATENTS, 1896.

APRIL 20.

8262. Apparatus for fastening and tightening wires for electric streams to insulators by means of a lever. Max Commichau, Zwickau, Saxony.

8269. An improved system of running and insulating concentric electrical conductors and appliances in connection therewith George Wilkinson, 73, St. Stephen's-road, Upton Park, London.

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8271. Improvements in or relating to electric traction. Wilfred Swanwick Boult, 111, Hatton-garden, London.

8308. Improvements in or connected with electrical resistances. Valere Alfred Fynn, 47, Lincoln's-inn-fields, London.

APRIL 21.

8316. Improvements in electric switches. Elmer Howard Wright, James Jean Heckman, Albert Henry Graves Charles Calvin Carnahan, and William Henry Carnahan 11, Southampton-buildings, Chancery-lane, London. (Complete specification)

8320. Support or bearing for electrical accumulators or other apparatus; having for its object the minimising of vibration. Guiseppe Fabbro, Morton House Trott street, Battersea, London.

8323. A new or improved process of electrically treating fabrics for waterproofing and other purposes. Charles Melbourne White, 27, Southampton-buildings Chancery lane, London. (The Electro Waterproofing and Dye-Fixing Company, United States) (Complete specification.)

8336. Improvements in and connected with electric tramways or railways. Andrew George Adamson, 154, St. Vincent-street, Glasgow.

8338 Improvements in the mode of connecting the car with the overhead wire in tramways worked by electricity. William Henry Kenway, 66, Corporation-street, Birmingham.

8380. Improvements in printing telegraph instruments. Benjamin Frederick Merritt and John Marston Joy, 45, Southampton-buildings, Chancery-lane, London (Complete specification.)

8382. Improvements in automatic circuit breakers for use in electric tramcars or other electrically-propelled vehicles. James Devonshire, 70, Chancery-lane, London. (William B. Potter United States) (Complete specification.)

8397. Improvements in electrical cut-outs. Henry Edmunds, 47, Lincoln's-inn-fields, London.

8398. Improvements in or connected with electrical resistances. Henry Edmunds, 47, Lincoln's-inn fields, London.

8399. Improvements in apparatus for completing, interrupting, and controlling electrical circuits. Henry Edmunds, 47, Lincoln's-inn-fields, London.

8410. Improvements in the electro-deposition of metals, particularly applicable to the deposition on wires. John Cameron Graham, 18, Southampton-buildings, Chancery-lane, London.

APRIL 22

8428. A new or improved electric switch. John Benjamin Verity, Plume Works, Aston. Birmingham.

8458 Improvements in electrical recording instruments. William Turvey, 4, Aubrey-walk, Campden Hill, London.

8483. An improvement in joints for electrical cables. Siemens Bros. and Co , Limited, and Wilhelm Dieselhorst, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8507. Improvements in chandeliers, gasoliers, electroliers, and other hanging lamps. James Hinks and Son Limited, and Francis Robert Baker, 7, Staple-inn, London.

8512. Improvements in or connected with drain pipes, water or electric conduits, and the like. George William Dolman, 7, Southampton-buildings, Chancery-lane, London.

8514. Improvements in electric glow lamps. Illius Augustus Timmis, 2, Great George-street, Westminster.

APRIL 23.

8541. Improvements in electric lamps for miners and in the method of lighting said electric lamps. William Woodhead, Commercial-street, Halifax.

8569. Improvements in apparatus for making electrical contact by passage of a railway train. Edward Tyre, 28, Southampton-buildings Chancery lane, London.

APRIL 24.

8630. Improvements in magnetic motors James Chandler, 10, St. George's-crescent, Liverpool

8647. Improvements in induction electrical machines. Frederick Tudsbury, 15, St. James-row, Sheffield.

8659 Improvements in paste-carrying plates for electric accumulators. Friedrich Wilhelm Schneider, 18, Buckingham-street, Strand, London. (Complete specification.)

8660. Improvements in the construction of cells for electric accumulators. Friedrich Wilhelm Schneider, 18, Buckingham-street, Strand, London. (Complete specification.)

8666. Improvements in and connected with battery electrodes. The Battery and Motor Company, Limited, and Harry Theodore Barnett, 433, Strand, London.

8682. Improvements in hand grenades and in electrical firing apparatus applicable for firing the same. Charles Ambrose McEvoy, 24, Southampton-buildings, Chancery-lane, London.

8684. Improvements relating to telephones. Francis Lauder Muirhead, 124, Chancery-lane, London,

8695. Improvements in electrodes for accumulators. Wilhelm Majert, 115, Cannon-street, London. (Complete specification.)

APRIL 25.

8743. Improvements in speaking-tube, telephone, and the like receivers. Hahnemann Adolphus Cutmore, 7, Quality-court, Chancery-lane, London.

SPECIFICATIONS PUBLISHED

1888

1851a Telephones, etc. Johnson. Volta Graphopone Company.) (Second edition.)

1892

11526. Electric cables. Hardingham. (Felten and Guilleaume.) (Second edition.)

24098. Alternating-current motors Brown. (Second edition.)

1895.

3954 Telephone systems Berditchewsky and Freudenberg.

6391 Electric lighting. Ballance and FitzMaurice.

7191. Electric arc lamps. Fisher.

7910. Lighting up roundabouts, etc., by electricity. Borland.

8764 Distributing electricity. Wright.

8876 E ectric batteries. Shrewsbury and others.

9816 Railway electric signalling apparatus. Robinson.

10313 Telegraphic or telephonic cables. Smith and Granville.

10614. Electric telephone systems. Sloper and Beckett.

10687. Arc lamps. Goold.

11016. Electrolytic decompositions, etc. Blackman.

11032. Secondary batteries. Eremin.

19364. Producing electric light Wise. (Moore Electrical Company.)

1896.

1687. Fastening electric conducting wires. Rudolf.

3133, Electric clocks Wiesner and Witzell.

4237. Electric motors. Devonshire. (Thomson.)

4427. Armatures for alternators, etc. Parshall and others.

4844. Arc lamps Adams.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1¼-1⅝
—— Non. Cum , 6 per cent. Pref.	2	1⅝-1¾
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	7¼-7
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7⅞-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16¾-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	133-135 xd
—— 5 per cent. Pref. Shares	10	14½-16
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	12¼-13¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2¾-2¾
Edison and Swan United Ordinary	3	1¼-1⅝
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	1¼-1⅝
—— 7 per cent. Cumulative Pref.	2	2¼-2⅝
Elmore's Copper Depositing	2	⅜-½
Elmore's Wire Company	2	⅜-½
Fowler-Waring Cables	5	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	16¼-17½
—— 7 per cent. Preference	10	16¼-17½
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	2½ 3⅜
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	22½-23½
—— 4½ per cent. Debentures	100	—
Kensington and Knightsbridge Ordinary	5	8½-8¾
—— 6 per cent. Pref.	5	7½-7¾
Liverpool Electric Supply, Ordinary	5	7⅝-7¾
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	16¾-16¾
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	⅝-¾
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	119-122
National Telephone, Ordinary	5	7½ 8½
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6½-7
—— 3½ per cent. Deb. Stock	100	108-111
Notting Hill Company	10	9-9½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	9/16-11/16 xd
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4½ 5½
St. James's and Pall Mall, Ordinary	5	10¼-10¾
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	6	8½-8¾
Westminster Electric Supply, Ordinary	5	9¾-10¼
Yorkshire House-to-House	5	7-7⅛

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NOTES.

The Mechanical Engineers.—At the anniversary dinner last week of the Institution of Mechanical Engineers, held at the Freemasons' Tavern, the principal guest was Mr. Bayard, the American Ambassador.

Vienna and Berlin Telephone.—According to the *Zeitschrift für Elektrotechnik*, telephonic communication has been in operation between Berlin and Vienna since April 1. The cost of a single conversation is about 3s.

Northern Electrical Engineers. — Mr. John Hesketh is to read a paper on the use and economies of rectifiers in arc lighting before the Northern Society of Electrical Engineers at Manchester on May 11.

Bacteria.— According to some experiments of Mr. Lortet communicated to the Paris Académie des Sciences, active bacilli are sensitive to the action of an alternating current, and arrange themselves parallel to the direction of it.

Sir John Pender Gold Medal.—This medal, of the value of £5. 5s., which is presented to the best student of electrical engineering at the Glasgow and West of Scotland Technical College, who at the same time obtains the college diploma, has just been awarded to Mr. Alexander H. Waddell, from Uddingston.

Petroleum Lamps.—The dangers of petroleum lamps have been enforced over and over again, but nobody troubles about "safety rules" for using them. To the list of deaths caused by these lamps must now be added that of Prof. Geffcken, who was suffocated in his sleep at Munich last week by the explosion of one left alight in his room.

Winkelmann's Solution.—As the basis of a solution for impregnating wood used in electric installations in order to render it uninflammable, the *Elektrotechnischer Anzeiger* gives the following (Winkelmann's process): 33 parts (by weight) of manganese chloride, 25 of ammonium chloride in 1,000 of water, 20 of ortho-phosphoric acid, 12 of magnesium carbonate, and 10 of boric acid.

Zirconium Carbides.—The researches of Mr. Henri Moissan and others with the electric furnace have shown that under the influence of the electric arc zirconium forms a carbide of the formula ZrC_2. It now appears that at lower temperatures another carbide of the formula ZrC is produced. This does not decompose water, but is attacked by acids and by oxidisers—in the latter case very vigorously.

Obituary.—There died last week in London, from heart disease, at the age of 75, Peter John Margary, one of the assistants of I. K. Brunel in the construction of the Bristol and Exeter Railway, and subsequently of the South Devon line, of which and its branches he became chief engineer on the death of Brunel. On the amalgamation with the Great Western Company, Mr. Margary was appointed resident engineer of the western division of the system, a position he retained until 1891.

The Earl's Court Show.—The electric illuminations were always a striking feature at the Indian Exhibition, and it will be remembered that the machinery of the generating station there has been the subject of an article in this paper. It may now be noted that one of the additions to the show for the present year is to be a Belvedere tower, 250ft. high, with a "4,000,000-c.p. lamp" at the top of it. That ought to be a noticeable feature in the neighbourhood at night-time.

Institution of Electrical Engineers.—There is to be a students' visit to the Robertson incandescent lamp factory at Brook Green, Hammersmith, on Friday, May 15, at 5 p.m. The party is limited to 20, and those desiring to be included should communicate with Mr. Allingham, at Eldon House, Lyndhurst-road, Hampstead. It should be added that "an assurance is required by the General Electric Company from each student joining the party that he is not commercially interested (directly or indirectly) in incandescent lamp manufacture."

Exhibitions.—May 1 was the day for the opening of the Swiss National Exhibition at Geneva, and also of the Berlin Industrial Exhibition, which occupies an area to the east of the Kaiserstadt, on the Spree, the grounds being nearly one-third larger than those occupied by the last Paris exhibition, or by any other exhibition ever held in Europe. The Hungarian Exhibition was also opened on the same day at Budapest. In Vienna, which likes to look down upon the Hungarian capital, having no exhibition to open, they had a labour riot instead. On the whole, this time Budapest seems to have had the best of it.

Royal Institution.—The annual meeting of the members of the Royal Institution of Great Britain was held last week, Sir James Crichton-Browne presiding. The annual report of the committee of visitors for the year 1895, which showed the continued prosperity and efficient management of the institution, was read and adopted. The real and funded property now amounts to above £100,000, entirely derived from the contributions and donations of the members and of others appreciating the value of the work of the institution. Seventy-two new members were elected in 1895. The Duke of Northumberland was elected as president, Sir James Crichton-Browne, F.R.S., as treasurer, and Sir Frederick Bramwell, F.R.S., as secretary for the ensuing year.

Trinidad Rock.—It will be remembered that when the British flag was hoisted on the island of Trinidad in the South Atlantic, in order that it might be secured for the purposes of a cable to the Argentine, the Brazilian Government, to whom the island did not belong, and who had no use for it, protested vigorously. Among our multifarious foreign difficulties this particular one has been nearly forgotten; but the Brazilians are keeping it alive and in case purely "patriotic" motives might not be sufficient, they have started a report in Rio Janeiro that there are rich mines of the precious metals in the island. Considering the formation of the island, this is excessively unlikely. It is true that Mr. Knight went there years ago to find some silver—not with success. But then he thought he knew that someone had put the silver there first.

Waterloo and City Railway.—This company having successfully met and dealt with the engineering and natural difficulties incidental to such an enterprise, appears now to be likely to have to face a serious one of artificial manufacture. At a special meeting of the executive of the Engine and Crane Drivers' Union held at the chief offices, Barking-road, it has been decided to call out their members to enforce an advance of ½d. per hour and a code of working rules similar to those demanded by the members of the various federated building trades unions who are at present on strike. Between 300 and 400 engine and crane drivers engaged in the building industry in the Metropolis will be affected by this decision. It is stated in the *Daily Mail* that, as a result of this, the men working the engines and cranes for the Waterloo Railway have come out and that the pumping operations have ceased, and the entire foundations of the works are in danger of becoming flooded.

Proposed Spanish-American Cable.—A good deal of space continues to be devoted by *El Telegrafista Español*

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to the proposed Transatlantic cable from Spain to Cuba. No further details are at present obtainable of the conditions under which it is stated this cable will be laid by a "foreign firm" (a well known one); but Mr. Angel Guerra hopes that it will be stipulated that the cable shall be worked by members of the Spanish telegraphic service, deprecates the results of precipitate action, and complains of the habitual want of foresight of the Spanish authorities. Too rapid conduct of business is not usually a Spanish fault, and the position of the Spanish Government is just now a very difficult one. Admittedly it cannot lay the cable itself, and if it can get a cable laid for it on anything like the terms set out in Mr. Guerra's former articles, it will on his own showing be doing an exceedingly good piece of business, while the Spanish telegraph service will be no worse off than before.

"Knowledge."—The May number of *Knowledge* has been forwarded to us with a request for review. It is a magazine with a record of which no one need be ashamed. If at one time it was perhaps too exclusively astronomical and at another too photographic, it has always maintained a high standard for the work that has appeared in it, which is more than can be said for a great deal of what passes under the name of "popular science." The present number is a fair example of the wide range covered. Three articles relate to biology or natural history and two are astronomical. Mr. Hill writes about early English coins, and Mr. Vaughan Cornish endeavours to elucidate some of the phenomena of wave motion—an exceedingly difficult subject for popular treatment; but the article of the number is Mr. T. G. Pinches's article on three fragments of a Babylonian tablet, in which he has discovered some long-wanted information with reference to Chedorlaomer and the strength and importance of Elam about 4,000 years ago.

Cables to Spain.—Mr. Henniker Heaton wants the telegraphic rates to Spain reduced. Last Friday in the House of Commons he asked the Secretary to the Treasury, as representing the Postmaster-General, whether, seeing that the telegraph rate from England to Spain is 4d. per word, and only 2d. per word from England to Germany, he would state when the concession of the cable company to Spain will expire; and if any measures would then be taken for the acquisition of the cable by the British Government, with a view to a reduction of the rate. Mr. Hanbury said two companies had cables between England and Spain, the Direct Spanish and the Eastern. The license to land the cable of the former company on the shores of this country would expire in 1903, and the license for the cable of the latter in 1904. It was too soon to say what the action of her Majesty's Government would be at the time in question. Considering the way in which cables are being laid, or, at any rate talked about, it would certainly be rash to say what would be the proper thing to do in eight years' time.

Field Magnets.—Induction coils are wound in a number of sections, which effectively prevent too close proximity of those portions of the winding between which there is a high difference of potential. The New York *Electrical World* says "the frequency with which the insulation of 500-volt shunt field coils is punctured by abruptly breaking the field circuit suggests that the same method of isolated sections be applied to field windings." Our American contemporary adds that the sectional construction would greatly promote ease of repair. With sectional construction a fault could be located in its particular section and thus avoid the necessity of unwinding the whole magnet. Again, "if the magnet winding were designed to be highly efficient and used but little current, the breaking down of one of its sections would not disable it. By simply short-circuiting the defective section, or, in case of a ground, removing it from the field circuit altogether, the magnet winding would generate exactly the same magnetising flux as before, with the exception that it would run a little hotter and use a little more current."

Three-Phase Arcs.—In a paper read before the American Institute of Electrical Engineers, Mr. W. L. Puffer has given the results of observations on the alternating-current arc, which he has been studying mainly by stroboscopic methods. So far as the simple alternating arc is concerned, Mr. Puffer has not brought out much that is new, but he has carried on his investigations to arcs produced by three-phase currents. He states that the three-phase arc is less noisy than the single-phase, and its light is steadier and has less variation in its total intensity, owing to the fact that the current never stops, and there is always a positive carbon. Three-cored carbons, placed parallel side by side, with slight magnetising coils to keep the arc at the ends of the carbon, will give a very satisfactory light in the direction away from the tips, and may be used when it is desirable to throw the light all in one direction. Four carbons at 90deg. apart, each with a suitable resistance in series with it, and connected to quarter-phase tap wires on a Gramme ring or other generator giving quarter-phase circuits will also produce a rotary field arc of great beauty and interest.

The American Pacific Cable.—A telegram from Washington, dated May 6, states that the United States Senate Committee on Foreign Relations have agreed to the Bill for the construction of a United States-Hawaii-Japan cable, and authorise the Postmaster-General to contract with any company to lay the cable, the subsidy not to exceed 160,000dol. yearly. The report of Mr. Frye to the Senate on the subject declared that the Hawaiian cable was demanded by the exigencies of commerce. It referred to the importance of Pearl Harbour and the necessity for telegraphic communication with Hawaii to direct the operations of the Pacific fleet in case of war. The Americans seem to derive a fearful joy from talking about what they would do in the event of a war with Great Britain. This has to come into the report somehow, so it is mentioned that in the event of the severance of peaceful relations with Great Britain communications by way of Nova Scotia would be immediately cut off, and the United States would be dependent upon the cable from Brazil to Portugal. The cost of the new cable is estimated at 3,400,000dol., and the maintenance at 586,000dol. yearly for the first five years.

A Wonderful Lamp.—Mr. Rudolf Schnabel, of Dresden, has written to the *Elektrotechnischer Anzeiger* (May 3) to say that he has discovered a new material which will be of great service in electric lighting work. No details are given as to the constitution of the material, but it appears to be a powder. The weight used is a quarter of a gramme, and the price of it 6s. a kilogramme. The lamp takes the form of a marble slab, with a groove and a shallow cavity to receive the powder. Carbon leads are used. It is stated that 16 watts (four amperes at four volts) give a power of 20 candles; that the light is whiter than that of an incandescent lamp, but contains more yellow than violet rays. The temperature of the incandescing material is such that iridium wire at once melts and is vaporised within three or four minutes. Editorially, the *Elektrotechnischer Anzeiger* points out that the new lamp claims an efficiency of ·8 watt per candle as compared with 2½ to 3 watts for an ordinary incandescent lamp (in England we use lamps of lower efficiency than this), and makes the obvious remark that a low-potential lamp

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of this kind could not be used in parallel on any existing systems. It is added that the discovery of Mr. Schnabel will be one of far-reaching importance if the particulars given above can be maintained; the life of the lamp is reasonably long, and the cost of installation not too great. The result of trials of the lamp is still to be awaited.

Chronographs in Gun Ballistics.—Last Friday, at the Royal Institution, Colonel H. Watkin, C.B., in his "discourse" on "Chronographs and their Application to Gun Ballistics," remarked that in designing chronographs for gun work the object in view was to discover the resistance offered by the air to projectiles, and to measure the rate of the passage of a shot up the bore of a gun in order to determine the pressure exerted by the powder, and therefore the shape the gun should assume in order to resist that pressure. Colonel Watkin explained and showed in action his improved apparatus employing a revolving drum driven very rapidly by an electromotor, and he explained how the speed was determined accurately by comparison with the time taken by a weight to drop through a known distance, and also described a method of smoking the drum which ensured minute records. If it were just rubbed over with benzole in which a small piece of paraffin wax was dissolved, the records left by the spark were large and easily found, but at the same time had a minute centre which could be read with great nicety. Explanations were given of the modes of testing the accuracy of the records obtained by means of the induction coil and of measuring the retardation which, with the drum of the instrument as shown revolving at a circumferential speed of 65 miles an hour, was only equivalent to ·015in. Artillerists had not yet found a satisfactory way of ascertaining the velocity of shot just in front of the muzzle when for a certain time it was still gaining speed, but Colonel Watkin proposes to resort to photographic methods for this purpose.

Motorcart Legislation.—The Walsall Chamber of Commerce evidently do not like motorcarts. They have been discussing the subject and want a few provisions introduced into any Bill legalising their use. In the first place, all self-propelled vehicles should carry a red and a white light. They should be limited to eight miles an hour in towns, and should carry a "conspicuously-placed" speed indicator so that there should be no doubt about the speed they are going at. Besides the lamps, they should carry bells which must ring the whole time the vehicle is in motion. Also they must stop whenever anyone with a horse signals them to do so. Probably a motorcart with the above-mentioned bell-ringing arrangement would get signalled to stop a good deal in the course of a journey down the Strand. Lastly, when used for hire there must be a "certificated" person in charge. This is in the interest of the passengers. The harmless pedestrian may, it appears, be run over by an unlicensed person if the latter is riding for pleasure only. Copies of these preposterous regulations have been sent for approval to the six Saddlers' Associations, the principal Chambers of Commerce, all the M.P.'s on the Executive Council of Associated Chambers of Commerce, the Worshipful Company of Saddlers, Worshipful Company of Farriers, Worshipful Company of Loriners, Worshipful Company of Curriers, Worshipful Company of Leather Sellers, Worshipful Company of Skinners, Royal College of Veterinary Surgeons; and each association has been asked to obtain the support of Members of the House when the amendments are moved. Some of these bodies seem to be hardly the best qualified or disinterested judges as to the safety of motorcarts, but probably that is why the Walsall Chamber chose them. Unkind persons might suggest that what the Walsall people are afraid of is not so much being run down by motorcarts as that, if the latter come into use, there may not be so many horses in the streets, and therefore the harness and leather trades will suffer. Their fears are likely to be groundless in this respect for many years to come.

Methods of Teaching.—In last week's issue of *Nature*, in the course of a review, there occurs a remarkable plea in favour of teaching electricity on the historical method. Apparently, we are to begin with Gilbert and Cavendish, or even earlier. If life were long enough it might be possible for the student to acquire his knowledge in this manner, passing gradually from one incomplete conception to another, and taking up the properties of more or less impossible "fluids" only to discard them. But what would be the good of it all? Useful as the historical method has been in philosophy and politics in tracing the origin of laws, customs, and ideas, and explaining how it has come to pass that people have been ready to die for the sake of demonstrable falsehoods, in the teaching of practical physics it seems to have no place. It is not easy to judge how much a general knowledge of mathematics is retarded by the fact that under literary and historical influences we are compelled to obtain our introduction to geometry by means of a text-book written about 2,100 years ago before arithmetic was rationalised or algebra thought of. Experience shows that the way in which a principle is discovered is rarely or never the way in which it can be most clearly and succinctly stated. The first thing for the student to do is to understand. If he has time and inclination, he can go into history afterwards. Even now, most elementary electrical teaching begins with the frictional machine and its equivalents instead of with the dynamo and transformer. When some of our highest authorities are considering how in the interests of education this state of things can best be altered, it is curious to meet with a proposition to take electrical teaching further away from, rather than to bring it nearer, existing knowledge and practical needs.

Tramway Law.—In the United States each State makes and unmakes its own laws much as it pleases without regard to the rest of the country. This may have its inconveniences, but, if there are any, it is the Americans who feel them, while we on this side of the water can, if we are wise, profit by their experience. One result of the work of the Legislature of the State of New Jersey, which has just risen, is the addition to the statutes of five laws of importance relating to electric railways. These were drawn by the Association of Traction Companies of New Jersey, which includes every horse and electric railway in the State. Senate Bill No. 115 is intended to prevent the institution of suits for damages against any railway company by lawyers who offer to hunt up the evidence for the injured, and who take most of the money for their services. It appears that in America a number of law firms make a business of sending out detectives immediately after an accident to hunt up evidence, and that they get most of the money recovered and the injured person very little. Senate Bill No. 116 bears also on the subject of damage suits. It allows the trolley companies, when a suit for personal damages is brought, to apply to the court to have a physician appointed to make an examination of the injured person, so that the physician can qualify as an expert. Senate Bill No. 134 limits the time within which action for personal injury can be brought to two years from the time the person is injured. Senate Bill No. 181 gives the governing body of any municipality the power to grant a franchise by two ordinances instead of one—one granting the right of way, and the other containing a description of the places for poles, etc. Should

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any change be desired in the latter, the one ordinance can be amended without affecting the franchise of the road. Senate Bill No. 182 validates all franchises of trolley roads now established which might be invalidated by mere technical defects in the placing of poles or some similar cause. The Bill prohibiting trolley roads from carrying freight passed both Houses and is in the hands of the Governor. It was amended in the Senate so as not to apply to roads already carrying freight.

Liability for Crossed Wires.—Canadian law is not necessarily the same as English law, particularly in the province of Quebec, but the following case given by the Montreal *Star* may be of interest on this side of the water. It will be noticed that the inevitable fuse which does not act when it is wanted comes into the case and plays an important part. It should be added that the decision will be appealed from. Our contemporary says: "Hon. Justice White has rendered an important judgment at Sherbrooke, Que., in the case of the Richmond County Electric Light Company *v.* the Sherbrooke Telephone Association, condemning the defendants to pay plaintiffs 218·63dol., on account of the wrecking of a dynamo at the plaintiffs' station, through the act of the defendants in allowing one of their wires to cross the plaintiffs' and produce a short-circuit. There was a fuse placed on the plaintiffs' line, which was designed for the protection of the dynamos in the station; but this did not blow or melt at the time of the cross. The defendants contended that the fuse was an absolute protection, and that if there had been a short-circuit outside it surely would have blown; consequently the wrecking of the machine was caused, not by a short-circuit from outside, but by the defective construction and state of repair of the machine. Judge White ruled against this pretension, discounting the evidence of the experts, who, he said, were always interested in favour of the parties summoning them. More reliance could be placed upon the opinions of the electrical engineers, members of the American Electrical Institute, who had recently met to discuss this very subject, at Niagara, where the distinguished electrician, Walter E. Harrington, closed his paper with these words: 'The natural conclusion arising from the knowledge of the above data is that fuse metals are under no circumstances to be considered in the light or nature of a protection.' Out of the nine experts who joined in the discussion, not one of them expressed an opinion that the fuse is an inevitable protection. One of them said it was 'in most cases'; another said it was 'in some cases'; while Mr. Harrington was of opinion that in no case could it be absolutely relied upon as a protection. Judge White held the evidence adduced showed that the injury to the dynamo could have been so caused although the fuse did not blow; that the damage resulted from the contact which it was established had taken place; and that the defendants were to blame for that contact."

Very Long-Distance Transmission.—Paragraphs have appeared in the American Press to the effect that at the opening of the New York Electrical Exposition this week power would be conveyed to the Exposition from the dynamos of the Niagara Power Company at Niagara Falls. There were the usual allusions to Mr. Tesla, who appears to serve as a second string to the American journalist's bow when Mr. Edison has been done with, and so far as the general public were concerned there was nothing to show that there was not to be a transmission of power on a practical scale. As the distance from Niagara to New York is something over 450 miles, as things stand at present anything of the sort is out of the question. How long it may remain so is of course a different matter. The New York *Electrical Engineer*, however, tells us what is really intended to be done. It was desired to mark the completion of the electric power plant at Niagara and the contract made by the city of Buffalo for its delivery within the city limits by June, 1897, in some way at the National Electrical Exposition in May. With this end in view, the management obtained a model made to scale by Mr. G. R. Allen, of Philadelphia, for the Hon. Peter A. Porter, of Niagara Falls. The model was constructed under the direction of Dr. Coleman Sellers, of the Niagara River, and shows the power-house, the town, and the long discharge tunnel, with the turbines in actual play operated by water from the canal and driving the generators. The model is 12ft. by 4ft., and will be given a place of honour on the main floor. It then occurred that, as little power was required to drive the turbines, it might be comparatively easy to switch on a modicum of current from the Falls plant and actually run the model with it, not as an ideal exemplification of what might be done, but more as a pretty *tour de force*. To get the circuit was the problem, but General Eckert, president of the Western Union Telegraph Company, authorised Mr. A. S. Brown, the electrical engineer of the company, to place two of their ordinary copper commercial wires at disposal, for use every evening, say for an hour or so, when the weather conditions are normal. Mr. L. B. Stillwell, of the Westinghouse Company, was asked to co-operate with Mr. Brown in working out the details, it being the intention to use the Tesla two-phase system and apparatus. A further suggestion was to hang some American Bell long-distance telephones over the exhibit and thus give the roar of Niagara as well as the model, and steps are now being taken to realise this.

The Metric System.—It is now no longer a secret that the articles in the *Times* in opposition to the adoption of the metric system were from the pen of no less a person than Mr. Herbert Spencer. They were doubtless somewhat of a surprise to many admirers of Mr. Spencer, who believed that the whole of his time was occupied with other matters. His last words on the subject are: "Arguments and expressions of opinion may be continued without end. Against those of Lord Kelvin and Dr. Stoney I will simply set some facts already stated, joined with one other: (1) Always mankind had the decimal system at their finger ends, and used it for counting. In the course of civilisation they departed from it in their systems of weights, measures, and values, gradually adopting instead sets of easy aliquot divisions, especially duodecimal divisions. (2) For half a century and after the metric system had been legally established the French did not discover its convenience. The alleged discovery of its convenience went along with the discovery that they would be punished if they did not use it. (3) In the United States, where the decimal division of money is used, it has been departed from in the centre of most active business, the Stock Exchange, and a system of easy aliquot divisions employed in its place. (4) The additional fact not yet named is sufficiently striking. The ancient wise men of the East and the modern working-men of the West have agreed upon the importance of great divisibility in numerical groups. The Chaldean priests, to whom we owe so much, doubtless swayed in part by their astronomical arrangements, adopted the sexagesimal system of numeration, which at the same time facilitates in a special manner the division into aliquot parts. For 60 may be divided by 10 different numbers—2, 3, 4, 5, 6, 10, 12, 15, 20, 30. From this significant fact turn now to the fact presented in our ordinary foot-rule. Each of its 12 inches is halved and rehalved, giving halves, quarters, and eighths. And then if we consider the subdivided

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foot as a whole, it gives us 10 sets of aliquot parts. Beyond its twelfths the divisions yield $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{6}$, $\frac{1}{8}$ ($1\frac{1}{2}$in.), $\frac{1}{16}$ ($\frac{3}{4}$in.), $\frac{1}{24}$ ($\frac{1}{2}$in.), $\frac{1}{32}$ ($\frac{3}{8}$in.), and $\frac{1}{48}$ ($\frac{1}{4}$in.). And this ordinary mode of dividing the foot-rule results from the experience of centuries; for builders, carpenters, and mechanics, always buying foot-rules which best serve their needs, have gradually established the most useful set of divisions. Yet now, though the early men of science and the modern men of practice are at one in recognising the importance of great divisibility, it is proposed to establish a form of measure characterised by relative indivisibility."

Motorcarts.—On Friday last the Motorcar Club gave a private view of several of the self-propelling carriages and cycles which will form part of the forthcoming exhibition at the Imperial Institute. The majority of the machines were driven by oil-motors of various types, but there was an electrical carriage designed by the Universal Electrical Carriage Syndicate and a Serpollet steam-carriage. The latter, though heavy and clumsy in appearance, made as little noise as any of the machines, and gave off no smoke or smell. The show was attended by many well-known people, including Lord Harris, who, as under-secretary for the Board of Trade, has charge in the House of Lords of the Bill removing existing restrictions on the use of self-propelled vehicles on the public roads. The inaugural dinner of the club took place on the same occasion, the chairman of the club, Mr. H. J. Lawson, presiding. Among the speakers was the Comte de Dion, president of the Automobile Club of France. The International Horseless Carriage and Roads Locomotion Exhibition at the Crystal Palace was opened last Saturday by the Lord Mayor. Prior to the opening function the palace directors entertained a large party to luncheon in the grand summer dining-room, Mr. G. T. Rait presiding. In addition to the City functionaries, there were present, among others, Sir Redvers Buller, Lord Harris, Sir David Salomons, Lord Provost Dewar, Sir A. Harris, Mr. Wyndham Portal, Sir E. M. Shaw, Major Flood Page, and Prof. D. E. Hughes. As for the show of motorcarts, the Universal Electric Carriage Syndicate exhibit an electrically-propelled phaeton to carry four persons. This carriage has already run over 100 miles in London. The same exhibitors show an electrically-propelled landau to carry four persons inside and two out, and also an electric van in course of construction for a London firm of contractors. The Electric Motive Power Company have on view an omnibus propelled by electricity to carry 26 persons. In appearance it is very like the ordinary tramcar, but it does not require metals to run upon, and it is constructed to give each passenger 4in. more room than the horse-drawn omnibuses. This has been built for the London Electric Omnibus Company, who anticipate having 125 similar conveyances running in the London streets at an early date. In the same class there are shown an electrically-propelled cab, and a victoria to carry two persons. In the class for vehicles propelled by petroleum motors Sir David Salomons exhibited a very neat carriage for four persons propelled by benzoline; but though it worked admirably, Sir David has not got over the two drawbacks of benzoline carriages—the disagreeable smell of the benzoline and the extreme vibration when the vehicle is stationary. There were, of course, a number of other steam and benzoline vehicles.

The Royal Society.—The first conversazione of the Royal Society was held on Wednesday night. There was, of course, a distinguished company present, and the exhibits were even more varied and interesting than in past years, and some of the demonstrations and experiments were extremely striking. So far as the exhibits connected with magnetism and electricity are concerned, Prof. Ewing showed a new apparatus for measuring the magnetic permeability of iron and steel. Prof. Roberts-Austen showed several curious experiments which are modifications of one recently described by Margot, of Geneva. A fine wire of aluminium is heated to no less than 400deg. above its melting point, but the wire nevertheless remains intact. This is owing to the formation of a fine film of alumina on the surface of the wire, and the metal, being very light, does not run into globules, as it might be expected to do. As the molten wire has a current passing through it, it will, if approached by a similar wire or by a magnet, enable all the effects of mobile conductors carrying currents to be illustrated. One experiment showed that the molten wire can even be twisted on itself without rupture, and the effects of a tenacious thread of molten metal moving in response to electrical influences are very singular. Mr. E. H. Griffiths showed a novel self-testing resistance box and bridge; Mr. F. W. Burstall showed a resistance-box, standard coils, and wire bridge, and bare wire resistance thermometers for use in vessels under high pressure. Mr. Joseph Goold exhibited a new synchronising sound generator, which is a vibrating bar having the pitch or vibration period of the note to be elicited. The separate partial tones can thus be developed singly with remarkable power and sweetness, and the clear gong-like note of the bars could be heard in all parts of the crowded rooms. These appliances have already led to the further curious discovery of vibration axes and vortices, examples of which were exhibited. Prof. Boys's exhibit was a geometrical arrangement of wall brackets and steady blocks, likely to be of great service in conducting physical experiments. The Cambridge Scientific Instruments Company exhibited a very delicate bifilar pendulum in action, designed by Mr. Horace Darwin, for observing and recording slow tilts and pulsations of the earth's crust, by whatever cause they may be produced. It is a modification of that used by the Messrs. Darwin in 1881 at the suggestion of Lord Kelvin. Prof. Dewar is not a frequent exhibitor at the Royal Society soirées. Last night he projected on the screen by means of the electric lantern some of his famous experiments with liquid air. Prof. Worthington and Mr. R. S. Cole showed instantaneous photographs of splashes taken each with an electric spark giving an exposure of less than three-millionths of a second. The spark could be so timed as to pick out any desired stage of the splash. In this way the progress of a great variety of splashes has been followed in minute detail. Especially interesting are those which illustrate the formation of a bubble. Prof. Hartley exhibited photographs of spectra illustrating his discovery of the presence of the rare metal gallium in the Middlesbrough iron ore Of course the "new photography" was much in evidence. Mr. Sydney Rowland exhibited a series of Röntgen photographs, and the process was demonstrated by Mr. Campbell Swinton. Several of the distinguished visitors seized the opportunity for having their hand and arm bones "skiagraphed," and a number of pictures previously taken were thrown on the screen by the electric lantern. These included a view of Lord Salisbury's hand, exhibiting, said the demonstrator, "distinct marks of incipient gout." Mr. Herbert Jackson gave a beautiful demonstration of the use of phosphorescent materials in rendering Röntgen rays visible. For the rest there was an opportunity of comparing Mr. Ives's and Mr. Lippmann's methods of colour photography, and a quantity of the mangled gas-bottles, the results of experiments on steel gas cylinders, exhibited by the Gas Cylinder Committee lately nominated at the request of the Home Office, should have been of practical interest to lecturers using limelight lanterns.

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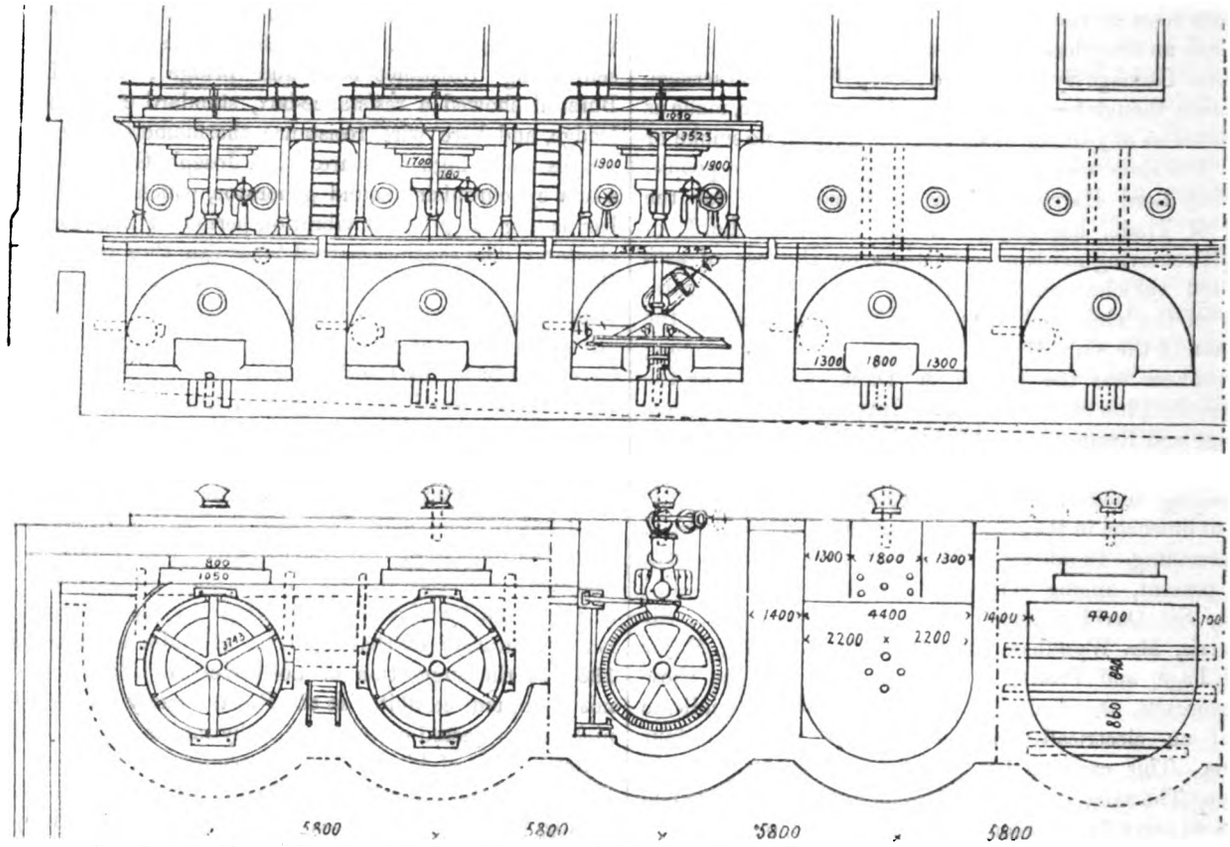
THE BRITISH ALUMINIUM WORKS AT FOYERS.

(Concluded from page 459.)

The arrangement and the details of the turbines can be seen from the plan, elevation, and section of the general arrangement of the plant (Figs. 7, 8, and 9). As will be seen, the shaft is vertical. It rests on a lens-shaped footstep of hardened steel. The control of the turbine is effected by the hand-wheel on the left side of the machine, while the handle controlling the sluice-valve on the pipe is on the right. No governors are provided, as the load is fairly steady and can be regulated by attention to the furnaces. The turbines were designed and manufactured by Escher, Wyss, and Co., of Zürich.

The large dynamos, five in number, have each an output of 7,500 amperes at 64 volts. They are direct coupled to the vertical shaft of turbines, and run at a speed of



FIGS. 7 AND 8.—Plan and Elevation of the General Arrangement of the Power Plant at Foyers. The Dimensions are in Millimetres.

150 revolutions per minute. The 480 kilowatts output is guaranteed by the makers under the following stringent condition: each machine is to be run continuously 24 hours a day for seven consecutive days at full load, without any sparking at the brushes even when the load is suddenly varied, and also without undue heating at any part of the dynamo. The general view of a dynamo as it appears when erected is shown in Fig. 10.

The construction of these machines can be seen from the section (Fig. 11). The magnet frame is of soft cast iron, and is supported on lattice-work columns from the floor of the engine-room. The machine has 24 poles, so designed that the magnetic coils, each of which weighs some 3cwt., can be slipped on easily. The iron is worked considerably above the saturation point so as to neutralise the back magnetisation of the armature at varying loads.

The armature has an external diameter of 8ft. The core is built up of soft-iron stampings carried on a strong cast-iron spider. The winding is on the multipolar drum winding system, with parallel connections at the ends. There are special equalising connections between all the bars of equal polarity, so as to prevent equalising currents passing through the sections of the armature winding if the voltage generated in the various sections should not be exactly the same. The bars are placed on the periphery of the iron core, and are held in place by passing through holes in five sheet-brass discs, which are specially inserted into the armature body for this purpose. Thus no binding wires are necessary, but they are nevertheless used as a special security. Additional insulation is used where the bars pass through the brass discs. Some such method of resisting the centrifugal stresses must be adopted in such large-diameter armatures running at a speed, like in the present case, of 3,750ft. per minute. Fig. 12 shows a finished armature of this type, but of rather smaller size.

The commutator has a diameter of 6ft., with a surface 15in. long. It is of special hard bronze, and insulated with mica. It has 216 segments. (Machines of the same type have been running continuously for nearly four years at Neuhausen, and up to the present moment no appreciable wear on the commutator has been noticed). Besides this main commutator there are two auxiliary commutators on the armature, for the purpose of making the armature-bar connections. Thus the main commutator can be removed and renewed, if necessary, without disturbing the armature winding.

A very important feature with a machine for large currents is the brush arrangement, and therefore special care has been taken in designing it. There are two large rings of solid cast copper, which are fastened horizontally

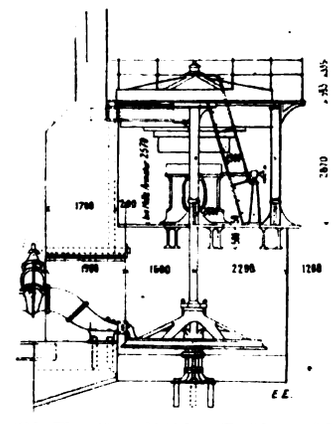


FIG. 9.—Side Elevation of 700-h.p. Turbine and Dynamo.

to a cast-iron support with bolts and insulating bushings. Each of the rings carries 12 massive brush-holder studs of copper-bronze. Each stud carries five brushes, so that there are 120 brushes all around. The dynamos have been supplied by the Oerlikon Company, and were designed

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by Mr. Emil Kolben, who kindly showed the machines while in course of construction to our special correspondent at the Verband meeting last year. The details of the machines now published were then kindly promised to us. We gave a little information about the design of these dynamos in the "Interview with Mr. Kolben," published on August 30, 1895.

The whole of the British Aluminium Company's plant will be placed under the superintendence of the resident engineer, Mr. C. T. H. Weiss, A.M.I.C.E., who has also charge of the erection of the electrical machinery, and will act as general manager at Foyers. The civil engineering in connection with the tunnel, pipe line, and general arrangements has been placed in the hands of Mr. W. Graham, who has superintended the work throughout.

The landing stage has had to be enlarged to meet the requirements for landing the heavy part of the dynamos, and the approach to it has also been widened by blasting.

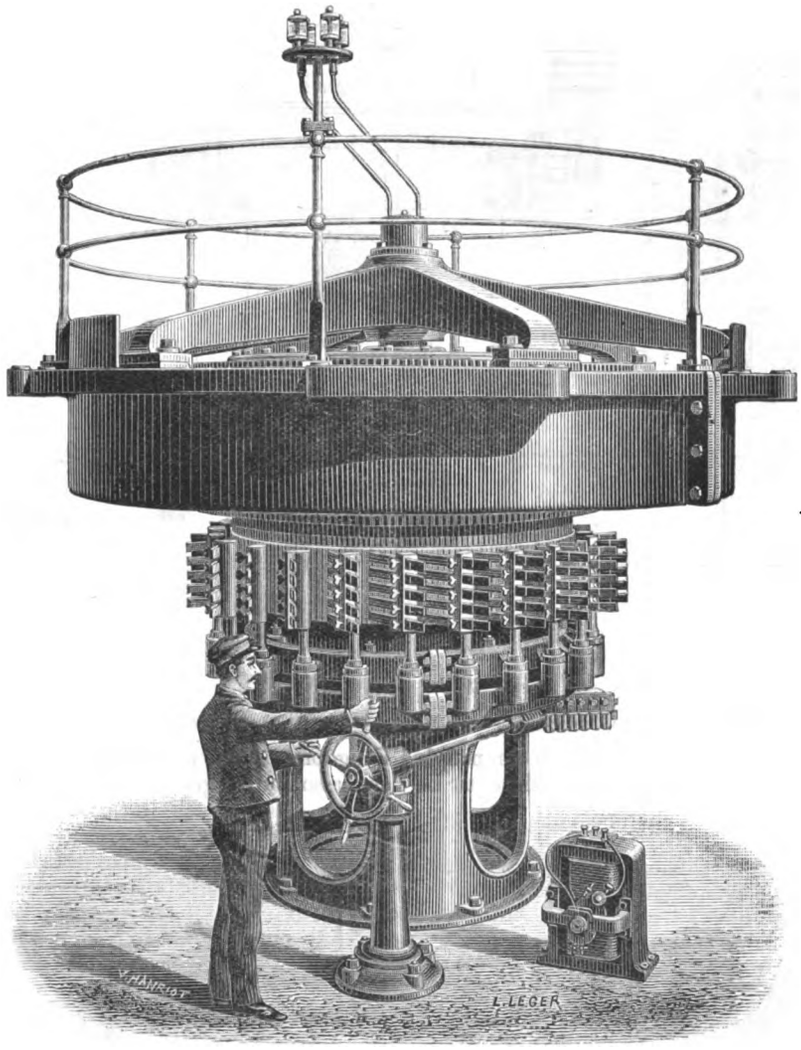

FIG. 10.—Perspective View of 480-K.W. Direct-Current Dynamo used at the Aluminium Works at Foyers.

A general view of the landing stage, as far as now completed, is shown in Fig. 13.

As explained above, the process for making aluminium at Foyers will be the same as that so successfully used at Neuhausen—hence the following details of the process used there, taken from Mr. W. Richards's valuable book on aluminium, will be of interest to our readers. The operation is begun by placing copper broken into rather small pieces in the crucible. The carbon anode is then approached to the copper, which is quickly melted by the current. The bath of fluid copper then becomes the negative pole, and ore is immediately fed into the crucible. It also is soon melted, and floats on the top of the copper. The electrolysis now proceeds, care being taken that while the anode dips into the molten ore it does not touch the molten cathode. Particular stress is laid on the economy of keeping the distance between the electrodes small, the reason given being that the space between, being filled with a layer of badly conducting molten ore, offers a resistance which increases with the distance, and although resistance is necessary, in order that the current should produce heat, it is not economical to have more heat than necessary to melt the ore, the work of separating the metal from the oxygen being chiefly done by the electrolytic action of the current, and not by the high temperature. In practice, this intervening space is not over three millimetres ($\frac{1}{10}$in.) The workman in charge, by watching the indication of the ampere-meter, is enabled to maintain the anode at its proper distance without any difficulty; it is proposed to do this regulating automatically by means of an easily constructed electrical device. The oxygen liberated gradually burns away the anode, it being found that about 1lb. of the anode is consumed for every pound of aluminium produced. After the operation commences, the alumina is introduced as required, and cryolite is added to reduce the resistance of the bath of fluid ore.

The plant at the Rhine Falls as now operated consists of the 300-h.p. turbine used since 1888, two 600-h.p. Jonval turbines, and five others of 610 h.p. The water rights obtained by the company in 1887 from the Canton Schaffhausen allowed it to take from the Rhine 700 cubic feet of water per second, which at a fall of 20 metres (65ft.) give an effect of 4,000 h.p. The combined power of the above turbines exceeds this, but one is always kept at rest and only seven regularly run. The 600-h.p. dynamos are also of the Oerlikon make, and at 150 revolutions give a steady current of 7,500 amperes at 55 volts. This plant, working to its full capacity since the middle of 1893, turns out daily 5,500lb. of aluminium. The financial prosperity of the Neuhausen works is shown by the fact that the dividends paid have risen from 8 per cent. in 1892 to a steady 10 per cent. ever since, although the price of the aluminum produced has fallen considerably.

The British Aluminium Company have kindly sent us an

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interesting pamphlet on the uses of aluminium and its alloys, from which we learn that the aluminium made at Foyers will be cast into ingots and sent to the company's foundry and rolling mills at Milton, Staffordshire, to be worked up into forgings, sheets, rods, bars, tubes, etc. This industry will prove, therefore, when in full working order, essentially British in character, the power and all the raw materials being obtained within the United Kingdom. The properties of the metal and its alloys are also fully given. The following brief *résumé* may be of interest. The tensile strength of castings in aluminium of about 98 per cent. purity is 5 to 5½ tons per square

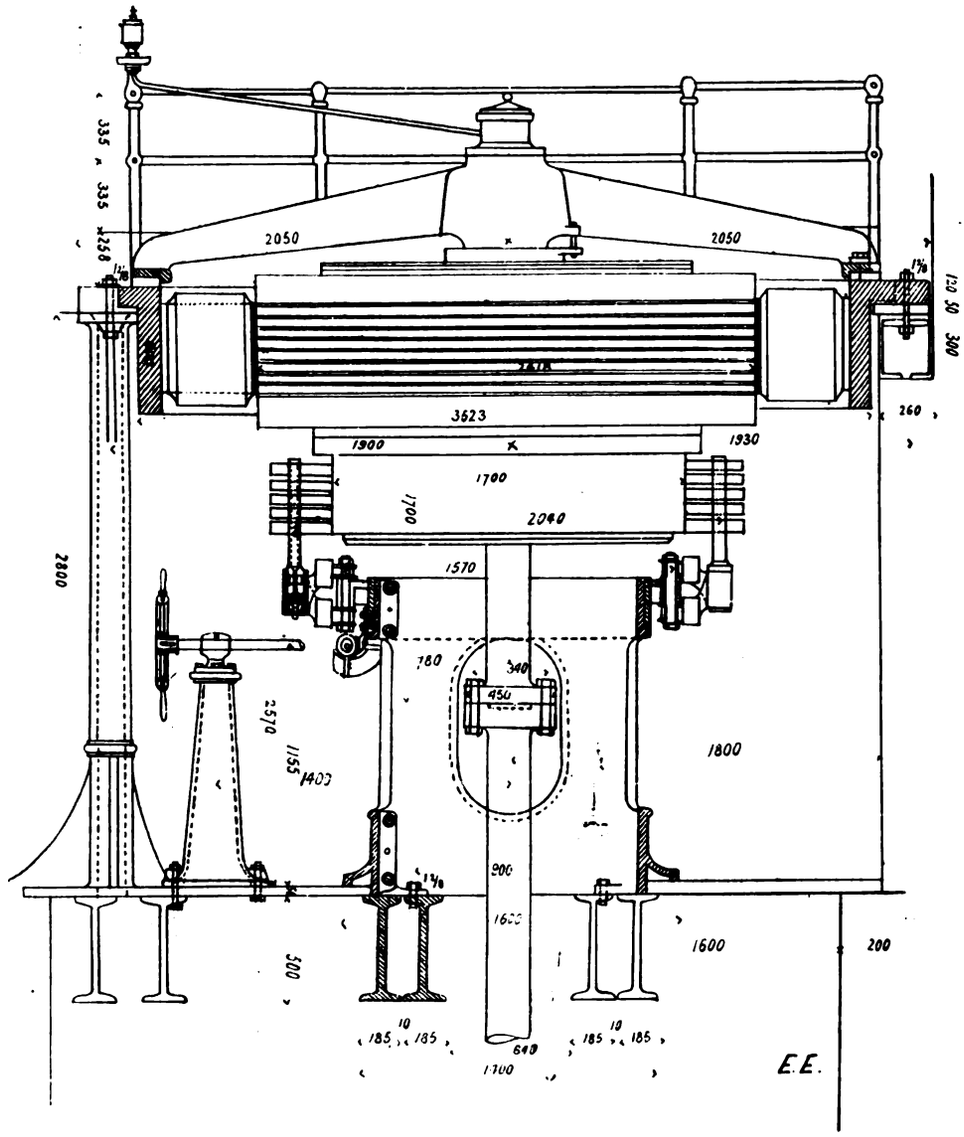

FIG. 11.—Detailed Sectional Elevation of the Oerlikon 480-K.W. Dynamos Installed at Foyers. The Dimensions are in Millimetres.

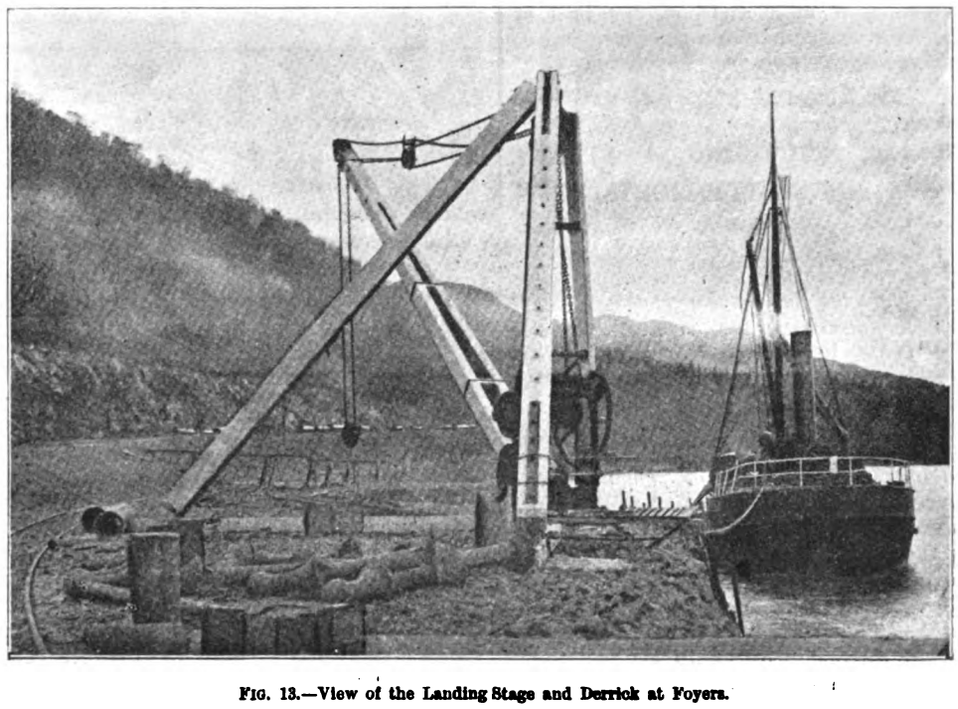

FIG. 13.—View of the Landing Stage and Derrick at Foyers.

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inch, with an elongation of about 2 to 3 per cent. (like ordinary cast iron). The specific gravity of pure aluminium is:

Cast in sand	2·56
Cast in metal moulds	2·60
Hammered or rolled	2·67
Hammered and drawn (wire)	2·71

The weight per cubic foot of cast aluminium is 158·90lb. The weight per cubic foot of rolled aluminium is 169·50lb. A cubic inch of cast aluminium weighs 0·092lb. Aluminium is practically non-magnetic. The specific resistance of the pure metal is 58·59, as compared with copper of 100. Pure aluminium is less affected by dry and damp air at ordinary temperatures, as well as at red heat, than any other metal, with the exception of gold and platinum. It also resists well the action of most of the acids met with in commercial processes.

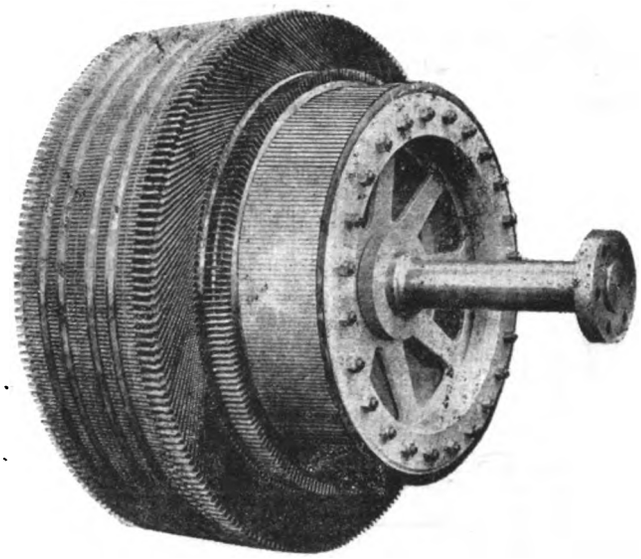

FIG. 12.—View of the Armature of an Oerlikon Multipola Dynamo.

The mechanical processes of forging, rolling, wire-drawing, spinning, etc., can be carried out with ease in the pure metal, and there is little difficulty in casting the metal. The melting point is 1,160deg. F., as no fluxes are required to prevent oxidation as when melting most metals.

A comparison of the present market prices shows that aluminium is at present, bulk for bulk, 5,433 times cheaper than platinum, 5,109 times cheaper than gold, 91 times cheaper than silver; that wolfram manganese, nickel, German silver, gunmetal manganese, and phosphor bronzes stand higher in price, and that aluminium can now successfully compete with copper, tin, and even brass.

AN APPARATUS FOR PROVIDING A STEADY PLATFORM AT SEA FOR SEARCH-LIGHTS, ETC.

BY BEAUCHAMP TOWER.

The author commences by stating that many intelligent people, when considering this subject for the first time, have suggested that this object may be attained without difficulty by hanging the to-be-steadied object in gimbals and attaching a good heavy weight underneath. They point to the bowl of the mariner's compass, or to the swing table commonly used on board yachts, as examples of objects steadied by these means. He then showed the fallacy of the idea that a pendulum hangs perpendicular on board a ship in a seaway. The swing table and the mariner's compass do not maintain a constant attitude with the horizon in a seaway, as looking along the top edge of either at the horizon will prove.

The late Mr. William Froude, in a paper on "The Rolling of Ships," read before the Institution of Naval Architects in 1861, describes the following experiment which he tried: He took an ordinary ring lifebuoy, and on it he erected a tripod, from which he suspended a plummet. When this was floated on waves, he observed that the plumb-line hung perpendicular to the wave-slope under all conditions, even in the extreme case of a curling-over wave breaking on a beach. In short, he found that a plumb-line afloat on waves departs as much from the vertical as the surface of the wave does from the horizontal, and cannot, therefore, be depended on, under those conditions, as an index of the true perpendicular. The author then proceeded to describe an apparatus for giving absolutely perfect steadiness to search-lights, machine guns, or other objects, even on a small, quickly-rolling vessel in a very rough sea.

A search-light projector throws a narrow ray of light not much more than a degree wide; and, in order that it may be of use for detecting the approach of torpedo boats or other objects at night, it must be held so steady as to

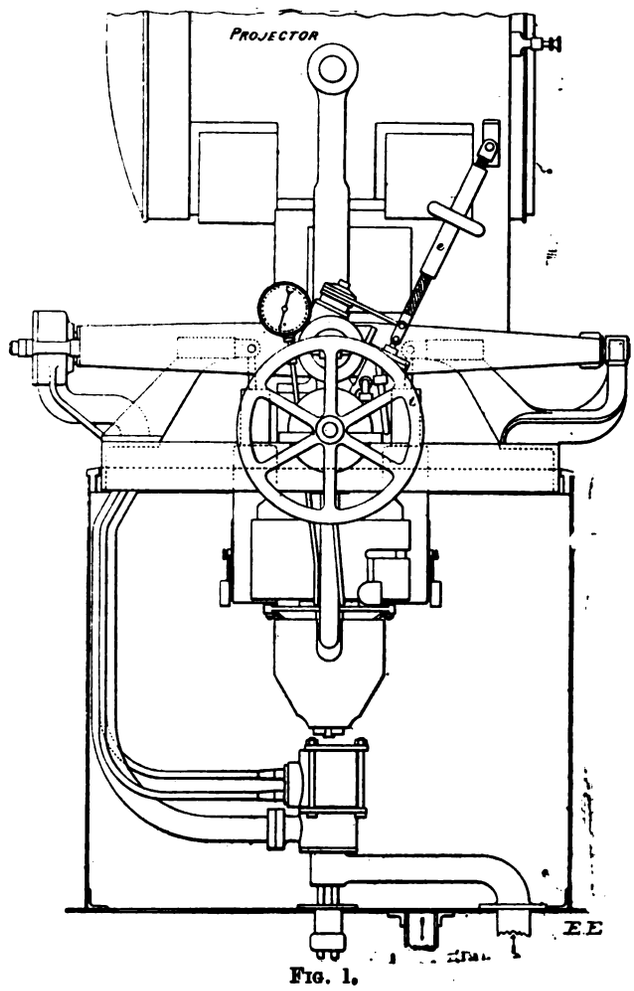

FIG. 1.

have no angular motion in a vertical plane comparable with the angle subtended by the ray of light, or it is impossible to keep the object in the field of illumination.

In this apparatus the platform (see Figs. 1 and 2), or part to be kept steady, and to which the search-light is attached, is hung in gimbals, so as to have angular freedom in every direction, in the same manner as the bowl of a mariner's compass. The gimbals are supported on a turn-table which runs on wheels on the top edge of a tank or pedestal, so that the light may be trained to any point of the horizon. At each of the four corners of the platform is fixed a cylinder, *k*, having a ram or plunger projecting upwards out of it, connected by a rod with a point, *e*, fixed relatively to the ship. If one of the rams is forced out of its cylinder by water pressure, it will cant the corner of the platform to which it belongs downwards in the gimbals, so that, by regulating the admission of water pressure to the four cylinders, the attitude of the platform in the gimbals can be controlled. This is done by the gyroscope revolving in a horizontal plane on a ball-and-socket bearing, supported on the centre of a cross-shaped frame which connects the bottoms of the four cylinders. The bodies of these cylinders project downwards

* Abstract of a paper read before the United Service Institution.

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from the platform, and are connected together by plates in such a way as to form a square cell within which the gyroscope revolves. The ball-and-socket bearing allows the gyroscope freedom to wobble or depart from the horizontal plane in every direction through an angle of about 3deg.

A supply of sea-water at the rate of 50 gallons per minute, and having a pressure of 100lb. per square inch, is pumped by a donkey engine to the platform, which it reaches by passing through the interior of the gimbal ring. This is made hollow for the purpose, and is provided with watertight oscillating joints in its bearings. The water can thus pass without leakage through the moving parts of the gimbals to the platform, and is conducted by pipes, *p* (Fig. 2), to the ball-and-socket bearing of the gyroscope, which is made hollow so as to provide a passage for the water into a chamber in the interior of the gyroscope. From this chamber passes two radial passages, *r r*, to the outside rim of the gyroscope, where they terminate in tangential jets, *t t*. These two jets are each $\frac{3}{16}$in. in diameter, and by their reaction cause the gyroscope to rotate at about 1,500 revolutions per minute. About one-third of all the water escapes through these tangential jets, and is used in giving the gyroscope rotation. The remaining two-thirds pass upwards from the chamber, and issue from a jet $\frac{3}{8}$in. diameter, which forms a prolongation of the upper axis of the gyroscope. It is this axial jet which provides the motive force for the controlling cylinders, *k k*, of the platform.

In order to make the gyroscope seek to revolve in a horizontal plane, four small pendulums are hung outside it. Each of these pendulums has a horizontal arm projecting from it; on the end of each there is a small wheel, *w*, which rests and presses lightly on the upper rim of the gyroscope. If the gyroscope is revolving in a horizontal plane all these pendulums press on it equally with their horizontal arms, but should the gyroscope be out of the horizontal plane, then one pendulum presses more and one less hard, in such a way as to cause it to seek the horizontal plane. Of course, these pendulums are subject to the disturbing forces of the wave-motion, as all pendulums are on board ship, and consequently do not tend to hang truly perpendicular to the horizon during the passage of a wave, but the gyroscope yields too slowly to the unequal pressure of the pendulums to take notice of these disturbances, which last only during the passage of a wave. Its position is that due to the mean of all the forces acting on the pendulums during a long period of time, which mean is the true perpendicular force of gravity.

We thus have a gyroscope revolving in a horizontal plane and throwing a truly vertical jet out of the axial jet nozzle. Immediately above the axial jet, and about $\frac{1}{2}$in. from it, are four open-mouthed ports, forming in a circle, divided by radial divisions into four equal sectors; their open mouths are directed downwards towards the axial jet. The passages, of which they form the terminations, communicate each to one of the four cylinders, *k*.

If the platform is truly horizontal, the axis of the axial jet passes through the centre of the circle containing the four ports, and the jet is equally distributed between them, but should the platform be the least bit out of the horizontal plane, some of the ports receive more of the jet than others, and this causes an inequality of pressure in the cylinders which cants the platform into the horizontal plane. The reason for using the jet as a connection between the gyroscope and platform is that it enables the gyroscope to powerfully control the platform and yet suffer no reaction on itself. A very small force would be sufficient to disturb the gyroscope from its horizontal plane of rotation, but no force can be communicated to it from the platform, as it makes no difference to the gyroscope what the axial jet strikes against after it has left the nozzle.

The first practical machine of this type was fitted up on a small steam yacht 50ft. long and 11ft. beam, and subjected to a laborious course of experiment, extending over about two years. It was experimented with by the officers of H.M.S. "Vernon" as a means of mounting search-lights, and by the officers of H.M.S. "Excellent" as a means of mounting machine guns. In both cases their reports showed that the machine answered the purpose for which it was designed perfectly. After these experiments a machine for mounting a 24in. search-light projector was ordered by the Admiralty to be fitted to H.M. gunboat "Bloodhound," tender to H.M.S. "Vernon," for further experiment, which showed that the machine could be depended on to keep a search-light ray absolutely steady on a small vessel in a heavy sea. Since then, Sir W. G. Armstrong, Mitchell, and Co. have taken up the manufacture of these machines, and are fitting it to the torpedo destroyers "Swordfish" and "Spitfire," which they are constructing for the navy. They are also supplying these machines to the order of the Chilian Government for a cruiser building at Elswick. There would be no difficulty in mounting the smaller class of quick-firing guns on these machines, of

PLATFORM.

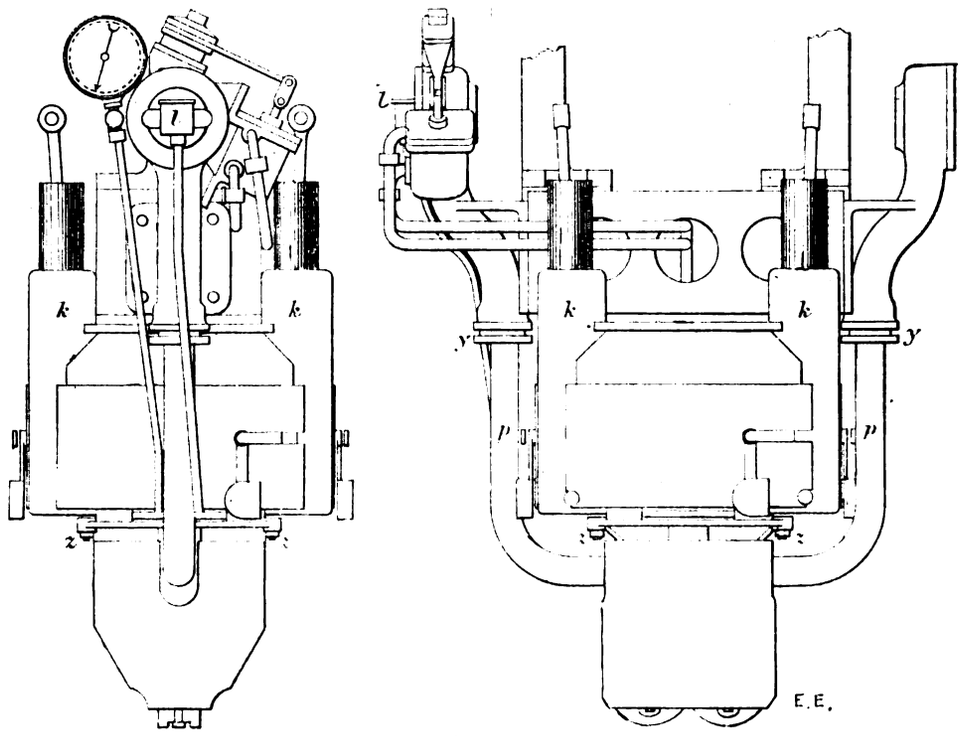

FIG. 2.

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course specially designed for the purpose; and on a small vessel, in which the motion is very quick and the difficulties of accurate shooting great, it ought to be very effective. For larger guns, an automatic firing apparatus has been designed for attachment to this machine, so as to fire the gun electrically at the right moment in the roll.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXX.

(Specially Contributed.)

Before sketching briefly the progression of invention in this class of magneto machinery, there is just one other experiment I want to show you. Fig. 1 shows a galvanometer which, for ease in making such experiments, instead of terminals, has contacts made by little mercury-cups in the base of the instrument, into which the ends of a conductor are brought. W represents a conductor

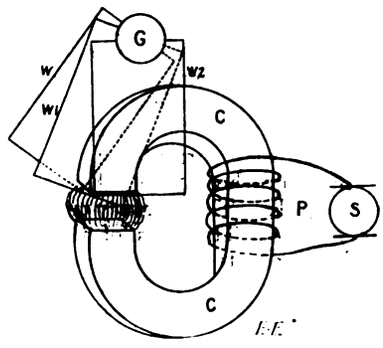

FIG. 1.

of insulated wire of a number of turns, the ends of which are taken into the mercury-cups of the galvanometer. I can swing the coil backwards and forwards without breaking contact with the galvanometer. Arrange this coil and galvanometer so that the coil can be swung backwards and forwards through the air-space of the core, C C. When connection is made with the source by means of the primary wire, P, around C C, lines of force are generated in C C and pass through the air-space, bulging out to cover more area according to the length of the air-space. For our purpose, suppose the lines go through the air, as shown.

First, let the conductor in connection with the galvanometer be in the position W.

If I make and break contact of the primary with source, no indication is shown by the galvanometer, because *none of the lines of force* loop, thread, or link—whichever term you like best—the coil W.

Second, let the coil with the galvanometer be in the position W_2. Now, when I make the primary contact, I get a deflection on the galvanometer, and the needle goes back to zero if I keep the contact made. Let the needle get back to zero, and then break the contact. The indication of the galvanometer is in the opposite direction to what it was before, but equal in value. We take it, then, that when making contact the lines of force looping W_2 caused a current flow of a definite magnitude, and when contact was broken there was an equal current flow, but in the opposite direction.

This is the common way of looking at the matter, but I would prefer to say that the looping of a coil by lines of force changes that coil from a normal condition to a different condition, and that when the lines are taken out or unlooped from the coil it returns to its normal condition. However, there is no manner of doubt but that the looping and unlooping of equal numbers of lines of force around a coil does produce equal but opposite effects.

Third, keep primary contact closed, and swing coil from position W_2 to position W; we get the same effect on galvanometer as when contact was broken.

Fourth, keep primary contact closed.

Swing from W to W_2, and note effect on galvanometer.

Swing from W_2 back to W, and note effect on galvanometer.

The effects are equal and opposite.

Swing from W to W_1, and note effect on galvanometer.

Swing back from W_1 to W, and note effect on galvanometer.

Still the effects are equal and opposite, but the value is less than in the previous cases, because the coil has only been looped and unlooped by a part of the lines of force.

Lastly (I am supposing C not saturated in any of these experiments), double the turns of the primary, and thus double the number of lines of force.

Swing from W to W_2 and back from W_2 to W as before, and you will find the effect as indicated by the galvanometer doubled, because the coil W is looped and unlooped by double the number of lines of force.

Such experiments can be multiplied a hundredfold, and all tend to prove that the current in any given coil depends absolutely upon the number of lines of force looped around that coil. It is as absolutely certain that when we consider the effect on a coil moving through a magnetic field we must consider the phenomena occurring both on looping and on unlooping (linking and unlinking seem to meet recent approval) of the lines of force. This has not been done by writers except in one or two cases. "Linking" and "linkages" are becoming common terms, and thus we have great hopes for the due recognition of unlinking.

From Faraday to De Meritens.—All the earlier machines had permanent magnets for the field magnets, hence are called magneto machines. This type of machine has now almost entirely given place to those having electromagnets as field magnets that I shall trouble little more than to briefly describe a few machines bridging, as it were, the time for half a century from the time of Faraday, and bringing us to that time when a marvellous development of electrical work took place. Not only did these early designers produce machines that acted as generators like those of Pixii and Saxton, but they designed motors, and endeavoured to transform electrical back again into mechanical energy. There are four machines of this latter kind that I would like to mention: Davenport's, because he was about the first—he ran a printing press with his machine; Sturgeon's, because he applied his to domestic uses—in fact, to a roasting-jack; Jacobi's, who applied his to the propulsion of a boat on the Neva; and Davidson's, which was used to propel a railway car.

Davenport, Sturgeon, Jacobi, and Davidson.—Davenport's machine is shown in Fig. 2, where C shows

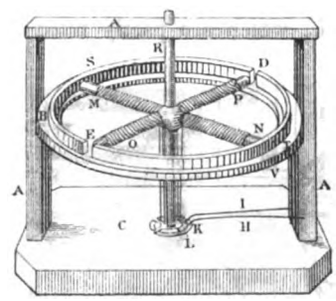

FIG. 2.

the base-piece, A, A, A the framework; H and I are conductors from a battery connected to copper contact-pieces, K L, in the form of segments of circles and corresponding in number with the magnets to be mentioned. The contact-pieces are around the shaft, with air-spaces between each other and the shaft. The alternate copper contacts are connected to the zinc pole of the battery and to the copper pole. Wires go from the contact-pieces to the electromagnets above. These magnets, M, N, O, P, are shown round the vertical shaft, R, which turns on pivots. The stationary magnets, S T, were either permanent, as shown, or might be electromagnets, with north and south poles at D and E respectively.

I ought, perhaps, here to explain that a dynamo machine is a reversible machine. Thus, if I link lines of force through a conductive circuit, I get an electric current in that circuit. Generally, I manage that linking by carrying

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the conductive circuit into and out of the magnetic field, and thus use mechanical energy. If, however, I send a current through a conductive circuit which is in a magnetic field, the conductive circuit by the current creates its own magnetic field. The two fields react on each other, and if one field is fixed in space, the other moves towards a space wherein there exists no field but that it takes. This motion gives us mechanical energy. A machine which some part is mechanically moved in order to get a current of electricity is called a generator; one in which a part moves because of the reaction between two fields is called a motor.

These machines I am now describing are motors. Davenport had his fixed permanent magnets, S T, with their fields. He sent a current through A I, around his electromagnets, M, N, O, P, and thus created their fields. The reaction between these fields causes the axle, R, with its radiating magnets, to spin round.

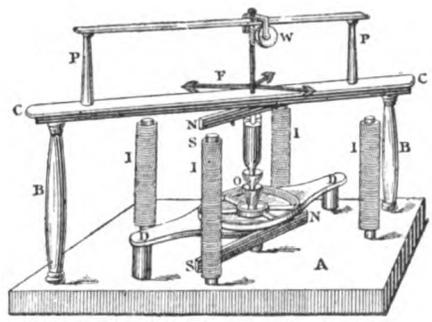

FIG. 3.

Sturgeon's apparatus is shown in Fig. 3. The base, A, carries pillars, B B, cross-piece, C C, with pillars, P P, cross-piece, and wheel, W. A central vertical shaft runs in collars, as shown, and passes through and is fixed to two circular channels, one above the other, also through a cross-piece, D D, supported by pillars. On D D are four quadrantal metal plates separated by air-spaces. Two compound bar magnets, N S, S N, are carried near the top and bottom of the shaft, as shown. Electromagnets, I, I, I, I, are fixed as shown. Each straight core carried six insulated coils. Each set of extremities of these copper wires is soldered to one stout copper wire; hence the extremities of the 24 coils terminate in eight of these latter wires, four of which proceed from the lower extremities of the coils, and are soldered to four quadrantal metallic plates, one to each. The other four stout wires proceed from the upper parts of the coils and terminate by proper connections in the circular channels, which are partly filled with mercury.

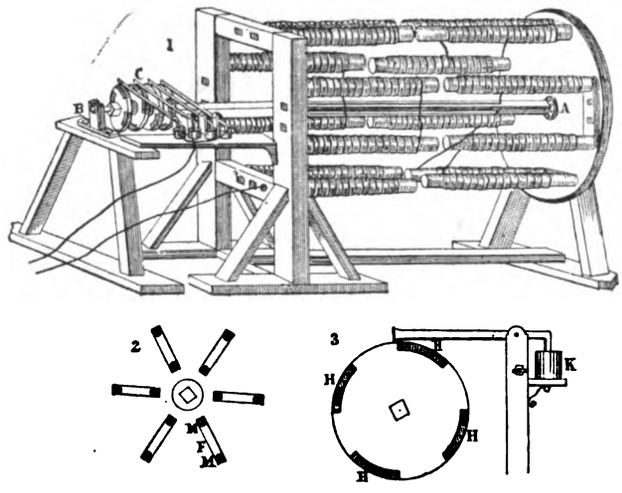

FIG. 4.

Through the sides of the channels pass four metallic stems, two through each, their inner extremities being in contact with the mercury in their respective channels. The stems of each pair are placed at 90deg. from each other, and the whole at right angles to the shaft. The right angle which the upper pair forms is on the opposite side of the shaft to that formed by the lower pair. From each stem hangs a metallic wire, reaching obliquely to its respective quadrantal plate on the cross-piece, D D, which maintains a connection between these plates and the mercury in the circular channels, transferring the electric current from one plate to another, and consequently from one coil to another in their progress of revolution. To prevent the figure being distorted, none of these connecting wires are drawn. Battery connections were made through the cross-piece, D D, and properly connected the electromagnets were magnetised in succession. This done, N S, S N and shaft rotated, and this rotation was conveyed to a roasting-jack.

Jacobi's apparatus (Fig. 4) was used to propel a boat on the Neva. It was rather cumbrous, but Jacobi himself, and soon after Stoehrer, of Leipsic, and Wagener, of Frankfort, greatly improved on the original, Stroehrer claiming to be able to get 45 h.p.—to propel a train of wagons with the usual complement of passengers from Leipsic to Dresden on the railroad for 6s. The fixed and revolving magnets of Jacobi's machine are shown at 1 (Fig. 4) in the illustration. He used electromagnets and a commutator to reverse the poles of the fixed magnets. 2. The commutator consisted of four pieces of copper on the axle, connected electrically two and two. The pairs were separated by a hollow axle of wood. The edge of each plate was divided into eight parts, four of which were hollowed out and filled with ebonite, the surface being flush. The copper plates are shown (No. 1, Fig. 4) arranged on the axle so that the sectors of wood and metal alternate. C C are contact-pieces or brushes to carry current from the battery. No. 3 shows one of these brushes better, the short end dipping into a mercury-cup, K. The mercury-cups were electrically connected by a wire. The coils of the moving magnets were electrically connected to the pairs of plates of the commutator. The coils of the fixed magnets ended in a mercury-cup connected to one pole of the battery, the other pole being connected to one of the mercury-cups, K, of the commutator.

PHYSICAL EXPERIMENT IN RELATION TO ENGINEERING.*

BY DR. ALEXANDER BLACKIE WILLIAM KENNEDY, F.R.S., M.I.C.E.

It has been the expressed wish of the gentleman in whose honour the "James Forrest" lectures have been instituted, that they should deal with the relation of various sciences to our own profession. To those of us (and they are many) who have long enjoyed his friendship, and who are to some extent familiar with the extent to which our profession is in his debt in matters innumerable, it is practically a duty to meet his wishes in such a matter. But it must be acknowledged that the duty—as regards the lecturer—must grow every year more difficult, as the field becomes limited by his predecessors; and even at present it was with no little nervousness as to the selection of a subject that I accepted last year the invitation to give this lecture in 1896.

There is perhaps no science, except those in the biological group, of which it might not be argued, with some degree of plausibility and reasonability, that the profession to which we all belong was a direct application. The sciences of mathematics and of physics, of chemistry and of geology, concern themselves with the exact statement of the nature and relations of facts and phenomena with which we as engineers have continually to concern ourselves. But the point of view of the purely scientific investigator and of the engineer, in regard to these facts and phenomena, are no doubt very different. In rare and exceptional cases one man can play both *rôles*, but this happens so very seldom that for all practical purposes they may be regarded as distinct from each other. And no one who is not terribly narrow—on one side or the other—would deny that either might form a worthy life-work for any man, however high his aims or ambition.

I excepted just now the biological sciences from those with which engineers were directly in touch. But, in spite of this, I confess that I have had a great wish for years past to devote some time to the working out of a theory of evolution in relation to engineering progress. I cannot help thinking that there is something in relation to things inorganic which closely resembles the position of natural selection in the organic world. The struggle for existence, which too obviously exists among engineers themselves regarded as organic beings, seems also to exist

* The "James Forrest" lecture delivered before the Institution of Civil Engineers, Session 1895-1896.

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in effect among engineering productions. There is also among them a survival of the fittest, and the laws which determine what is the fittest at any time, and how the standard of fitness alters as time goes on, are probably capable of fairly exact statement—in correlation with the laws of general human progress—at any rate they are very well worthy of examination. This biologico-engineering investigation would be no doubt rendered more difficult by the fact that artificial selection continually comes in to help and accelerate, or it may be to hamper and impede, but in any case to modify, the inorganic equivalent of natural selection. I have found this whole subject a most tempting one, full of fascination, and to some extent also of surprises. But finally I felt constrained to leave it, at least as far as this lecture is concerned, to someone—some fortunate person—whose mind was not so overcrowded with the innumerable details of everyday work as my own, or who was able, in spite of these details, to obtain at the same time a broad and comprehensive view of the whole subject from a point higher and more commanding than any that I seemed able to attain to. I hope that in some future year I may have the pleasure of listening to a "James Forrest" lecture in which "Evolution in Engineering" may be adequately dealt with. For myself I have found it necessary to be content with a much more limited subject, although one perhaps on which my own work gives me more right to speak, "Physical Experiment in Relation to Engineering."

We are all at this present time so familiar with the idea of physical laboratories—places in which physical experiment is carried out systematically and continuously, both for purposes of scientific investigation and of education—that it is hard to realise how very modern an institution the physical laboratory is. Until quite lately the most distinguished investigators worked in laboratories which they had made for themselves and which were essentially their own private studies. The Royal Institution laboratories—originally, I think, rather chemical than physical in conception—nevertheless became to a great extent physical, and in this way were early and notable extensions of the purely private laboratory, and happily exist still to furnish admirable physical work. But it is practically only within the last 30 years that physical laboratories, as we know them to-day, have come into existence. Thanks very much to this growth of experimental and physical teaching, we have now an army of trained physical investigators distributed all over the country, whose principal occupation (besides teaching) is the making of researches in experimental physics, and in this way contributing to our knowledge of the phenomena of the world around us, the phenomena which it is our business to turn to the "use and convenience of man." Not only this, but within the last 20 years there have come into existence numerous well-equipped engineering laboratories in connection with our technical colleges and schools. These engineering laboratories are, of course, simply physical laboratories modified in a certain special direction for our special purposes, and the investigations carried on in them are of the nature of physical experiment as fully and completely as those which are carried out in physical laboratories proper. The aim and scope of the two classes of experiment, however, differ considerably, as do their relations to our own work, and it will be my object this evening to put before you what, according to my own view, are the relations between these classes of experiment, and especially between each class and our own work. I need hardly say that I am bound to look at the whole matter throughout from the point of view of the engineer. I do not for a moment pretend that I am capable of taking up the position of the physicist, and, of course, I keep in mind also that I have to speak to an audience consisting essentially of engineers and not of physicists.

Physical experiment, so far as it has relation to our own profession, may fairly be considered to serve three distinct purposes. In the first place, from the purely academic or educational point of view, it is most important and helpful in the training of engineering students. (And it is well to remember that although a great many of us never were engineering students, nor had any opportunity of obtaining such training, yet the most conservative must now recognise that in the future our sons and successors must look on the student stage as being as essential as the pupilage or the apprenticeship.) Then, secondly, what may be called purely physical experiment is necessary to supply us with most of our most important constants, whether connected with the thermal properties of steam, the E.M.F. of a Clark cell, the density of water, the elasticity of steel, the coefficient for a *vena contracta*, or a thousand other matters of similar nature. Lastly, technical experiments, which are essentially physical experiments, but of a much more complex nature than those of the physical laboratory (although not on that account more difficult to carry out) are necessary for determining many matters, such, for example, as the efficiency of a dynamo, the steam consumption of an engine, the flow of a river, the resistance of a ship, or even the deflection of a girder under a moving load.

Let us consider, in the first place, the purely educative or academic type of experiment. Here the first requirement is the very simple one—which, indeed, may be served by an endless variety of experiments extending far beyond the limit of physics—that the student should learn first to see and to measure, and then to write down what he has seen and measured. Anyone who has had to do with laboratory work knows very well how necessary it is to differentiate in this fashion. The experiments require to be as far as possible quantitative rather than merely qualitative, but otherwise the simpler they are the better. It is unnecessary here to go into any details about them, but with a view to emphasising their importance it is worth while just to look for a moment at the sort of thing by which, in actual engineering work, these simple experiments may be said to be represented. Perhaps those whose work lies greatly in experimentation, like my own, know best how very hard it is to find assistants, unless they have been trained in a laboratory, who can be trusted at first even to take quarter-hourly readings of a steam-gauge or a counter, or any such duty, ridiculously simple and easy as it appears. To ask an untrained man to count the revolutions of an engine which has no continuous counter attached, or to read the dials of an ampere-hour meter, at exactly regular intervals of time, is merely to court disaster! The story is familiar of how Robert Houdin had so trained his faculty of general observation, that one look at a shop window would impress its contents on his mind more vividly and accurately than 10 minutes of hard looking would do in the case of an ordinary man. It is really just the same with the simplest of our observations. The ordinary mind does not naturally and at once see, and see accurately, the simplest thing that is before the eyes. One has to look, to exercise conscious mental effort, as well as merely to see, and we all of us require to be taught how to look, even in these most simple matters. And when the enforced looking has to be done at exactly a particular time and no other, the average mind is apt to find the whole process an intolerable burden, all the more because it is inclined to despise the work as being too childishly easy for consideration at the very time when it is failing to carry it out!

(To be continued.)

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

May 12, 8 p.m.—At the Institution, Great George-street, Westminster. Resumed discussion on "American and British Methods of Manufacturing Steel-Plate," by J. Head, and "Four American Rolling Mills," by S. T. Willmer.

Institution of Electrical Engineers.

May 8, 8 p.m.—At the Library, 28, Victoria-street. Students' meeting. "Single-Phase Transformers in Practice." By A. F. Berry.

May 9—Students' visit to the London Electric Supply Corporation's station at Stowage Wharf, Deptford. Train leaves Charing Cross at 10.20.

May 14, 8 p.m.—At the Institution of Civil Engineers, 25, Great George-street, Westminster. "The Influence of the Shape of the Applied Potential-Difference Wave on the Iron Losses in Transformers." By S. Beeton, C. Perry Taylor (student), and I. M. Barr.

May 15, 5 p.m.—Students' visit to Brook Green Works, Hammersmith.

Physical Society.

May 8.—"On Dielectrics." By R. Appleyard. "On the True Resistance of the Electric Arc." By Messrs. Frith and Rodgers.

Royal Institution of Great Britain.

May 8, 9 p.m.—At Albemarle-street, Piccadilly. "Electric Shadows and Luminescence." By Prof. S P. Thompson.

May 12, 3 p m—"Ripples." Prof. C. V. Boys.

May 14, 3 p.m.—"Japanese Metal Working." By Mr. Gowland.

May 15, 9 p.m.—"Cable Laying in the Amazon." By Alexander Siemens.

Institution of Junior Engineers.

May 8, 8 p.m.—At the Westminster Palace Hotel. "Notes on Belgian Electrical Engineering Practice." By A. Anstruther-Thomson and G. C. Allingham.

Society of Arts.

May 11, 8 p.m.—At John-street, Adelphi. Cantor lecture. "Applied Electro-Chemistry." By James Swinburne. (The third of four lectures.)

May 12, 8 p.m.—"Wood Engraving." By W. Biscombe Gardner.

May 13, 8 p.m.—"Tunnelling by Compressed Air." By E. W. Moir, M.Inst.C.E.

Northern Society of Electrical Engineers.

May 11, 8 p.m.—At the Palatine Hotel, Manchester. "The Use and Economies of Rectifiers for Arc Lighting." By John Hesketh.

Liverpool Engineering Society.

May 16.—Visit to the Southern Extension Works of the Overhead Railway.

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THE 1896 JAMES FORREST LECTURE.

The lecture under the above title delivered annually at the Institution of Civil Engineers is always looked forward to with interest. The subject this year is the relation of physical experiment to engineering. In the able hands of Prof. A. B. W. Kennedy the subject has received most careful treatment, which will cause the lecture for 1896 to be regarded as the classical work on these matters. The lecture is reproduced in our columns, and we only regret that space will not permit of it being given in its entirety in one issue. The whole of the treatise is worthy of close reading, and the views expressed have our complete approval. Dr. Kennedy draws a great distinction between the experiments of the scientific investigator and those of the engineer, and points out how few men can work in both of these widely-varying pursuits. Still, either course of research is worthy of the life-work of any man. The professor's introductory remarks on the theory of evolution in engineering matters opens out a wide field for thought, and we can only hope that this subject may be more extensively dealt with by the author at some early date, as his experimental studies of the details of certain branches of engineering enable him to speak with no uncertain voice on these matters. The three classes of physical experiments detailed by Prof. Kennedy are those undertaken from the purely educational point of view, the purely physical experiment for the determination of scientific facts, and, lastly, the technical experiment. The first class, as a training, is very essential to anyone who is afterwards to undertake experiments of the other classes, as an untrained man cannot as a rule observe and record his observations with any degree of accuracy. In this respect the members of the technical Press are apt to be specially at fault, more, perhaps, owing to the sunny side of engineering usually shown to them. We have often noticed in a description of some plant the expression that "the writer has never seen an equipment more complete and satisfactory," and yet it has been known to accurate observers that certain parts were even then in a disabled state. As pointed out in the above lecture, "the ordinary mind does not naturally and at once see, and see accurately, the simplest thing that is before the eyes. One has to look, to exercise conscious mental effort, as well as merely to see, and we all of us require to be taught how to look, even in these most simple matters. And when the enforced looking has to be done at exactly a particular time, and no other, the average mind is apt to find the whole process an intolerable burden, all the more because it is inclined to despise the work as being too childishly easy for consideration at the very time when it is failing to carry it out!"

The pure physicist has a much wider field of research than the engineer, and his researches are most useful in many ways to the engineer, as providing the constants used in engineering formulæ. Yet the engineer, having a more limited field for his researches, has a greater interest in his particular field of investigation because of its limitation. Thus, Prof. Kennedy justly "resents the way in which

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physical writers and speakers are occasionally inclined to instruct us how to express our ideas—for example, as to mass and weight, and sundry vital matters of that kind." He thinks "that people who have to deal with these matters as much, as often, and as thoroughly as we have, and who are on the whole reasonably competent beings, may be assumed to know how best to manage our own affairs in these respects. Mechanics are to us the breath of our nostrils, and not a mere vehicle for examination papers, and it should be remembered that the requirements of the latter case may be very different from those of what he ventures to call 'real life.'"

Again, the pure physicist carries out his observations on lines which tend to eliminate all but the effect he is investigating. His whole object is to one single end for the time being, and he so designs his apparatus as to exaggerate the special phenomena to be measured. The engineer, on the other hand, is always combated by conflicting interests. Thus, the £ with two crosses is as important in electrical matters as the £ which stands for self-induction, and in all engineering matters the cash considerations oft tend to prevent abnormally efficient work from being carried out. Again, the physicist aims at absolutely correct figures, which in the engineer's observation would be absurd. Thus, in the experiments made by the engineer the limitations as to accuracy are considered by Prof. Kennedy. It is useless to give the results of coal consumption per kilowatt-hour in the trial of a complete central-station plant in five or six significant figures, as some people delight to do, although at the same trial commercial voltmeters and ammeters are used to determine the outputs and are not checked. We entirely confirm the concluding remark in this lecture, stating the fact that the great strides made in perfecting the various engineering appliances during the last twenty years are due in a very great measure to physical experiment carefully made and carefully used as a guide to future work.

THE NATURE OF CHEMICAL CHANGE AND THE CONDITIONS WHICH DETERMINE IT.*

BY DR. ARMSTRONG, F.R.S.

(Continued from page 495.)

To explain the formation from chloracetic acid, for example, of salts on the one hand and of hydroxyacetic acid on the other, Ostwald assumes that it not only dissociates into the ions H and $CH_2Cl{\cdot}CO_2$, but also to a slight extent into Cl and $CH_2{\cdot}CO_2H_2$; his theory, in fact, forces him to assume that an electrolyte may ultimately split up in different directions. But no such difficulty arises in connection with the association theory. According to this, the manner in which change will occur depends on the nature of the substances present and the extent to which they are compatible—a compound, such as chloracetic acid, behaving as an acid when substances are present to which the acid radicle is attractive, as a chloro-derivative when substances are present which are more attracted by the chlorine, "local" circuits being established which proceed from and include one or the other part of the molecule, according to circumstances. As the changes which take place when such circuits are established will depend on the nature of the circuits, it is easy to understand the formation from chloracetic acid, on the one hand of hydroxyacetic acid, and on the other of dichloracetic acid, even supposing the chlorine to be the attracting element: the difference would depend primarily on the association with the chlorine atom either of an alkali or of chlorine—*i.e.*, on the difference in the associate. To account for the formation of dichloracetic acid on the ionic hypothesis, it is necessary to assume that chloracetic acid will ionise not merely in two ways, but also in a third—viz., into H and $CHCl{\cdot}CO_2H$. Nay, more, if the argument be extended, in order to account for the formation of chloracetyl chloride, $CH_2Cl{\cdot}COCl$, a fourth possibility must be admitted—viz., into $CH_2Cl{\cdot}CO$ and OH!*

I have dwelt thus fully on these questions, as, apart from the interest attaching to such problems, it is all important to establish the exact nature of the changes which attend the dissolution of metals and the precise character and functions of substances which act as depolarisers, our power to utilise chemical change at will as a source of energy depending on the extent to which we comprehend the inner meanings of all such changes. The function of the depolariser is far from appreciated, there being too marked a tendency to regard it merely as an agent whereby polarisation is prevented, the fact being often overlooked that it directly contributes in a very important manner to the energy of the cell, in many cases making changes possible which could not otherwise occur.

In all cases of chemical change energy is ultimately degraded, but in most cases a switchback rather than a simple inclined plane is the graphic analogue of a circuit of chemical change. Or, still better, we may liken it to a system of pipes laid up and down hill through which water is supplied to a town, in which case the function of the depolariser is comparable with that of the standpipe or accumulator at the pumping station, up and through which the water is forced in order to secure the head which is necessary to overcome the friction in the pipes and to cause water to mount the hills in the district supplied, as well as to raise it to the tops of the houses and in the fire-mains. Such hydraulic systems can only be constructed of pipes which can be fitted together, just as chemical changes can only be brought about between compatible substances. Lastly, those who enjoy a constant service have no right to assume that the supply of water is automatic. On the contrary, a complex organisation which may altogether escape notice is required to secure it. And so it may be in the case of electrolysis and chemical change.

Before concluding this section it is desirable to refer to the behaviour of electrolytes which yield a variety of products according to the conditions under which their electrolysis is effected. For example, that of sulphuric acid solutions which afford not only oxygen and hydrogen, but also persulphuric acid, hydrogen peroxide, and ozone. If action take place primarily in an electrolytic circuit in but one way, how are we to account for the formation of persulphuric acid? Its production would appear to afford evidence that the acid acts both as electrolyte and as "oxygen depolariser," which is against the conclusion previously arrived at. The difficulty disappears if it be supposed that the first products of electrolysis are hydrogen and persulphuric acid—*i.e.*, that instead of water being directly resolved into 2H and O, or the acid into H and HSO_4, or 2H and SO_4—the conventional views—the acid is couverted into 2H and $H_2S_2O_8$. Richarz some time ago advocated this view (*Zeit. physikal. Chem.*, 1889, 4, 28), and it is also in accordance with Ostwald's contention that the dissociation of dibasic acids of the form H_2R'' primarily takes place (in relatively concentrated solutions) into $H+HR''$. It may be supposed that under ordinary conditions, when the electrode surface is large, the decomposition of the persulphuric acid is determined by the tendency of the electrode to attract oxygen, whilst, if the electrode surface be small and the current density high, much persulphuric acid has the opportunity of escaping into the solution, and of remaining to a considerable extent unchanged if the acid at the electrode be more or less concentrated and favour its survival, but somewhat rapidly undergoing hydrolysis into sulphuric acid and hydrogen peroxide in weak solutions. The formation of ozone may in like manner be regarded as the outcome of oxygen depolarisation by the persulphuric acid—*i.e.*, of the interaction of oxygen on the electrode with the acid under the special conditions which attend high current density—or it may be that ozone, not oxygen, is the ordinary product, and that this in turn suffers decomposition at the electrode surface when this is large.

It is commonly assumed that we know what happens when a solution of hydrogen chloride is electrolysed—that, in fact, it is directly resolved into hydrogen and chlorine; indeed, the primary article of faith in the creed of the ionic dissociationist carries us even further, asserting, as it does, that the chloride spontaneously breaks up into hydrogen and chlorine ions, and that these, giving up their charges at the electrodes, form hydrogen and chlorine molecules. The production of chlorine may, however, be the outcome of secondary changes. Assuming that muriatic *acid* consists of hydrated molecules, let us suppose, of the composition $H_2O{\cdot}ClH$, these may yield a peroxide, $H_2O_2{\cdot}(ClH)_2$, which, in concentrated solutions, either breaks up into chlorine and water, or is so resolved under the influence of the acid, but in weak solutions undergoes hydrolysis, oxygen being evolved by the decomposition of hydrogen peroxide at

* Presidential address delivered before the Chemical Society.

* Why, it may be asked, should the atoms keep together at all, if they are thus willing to separate in so many ways?

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the electrode surface. Or it may be that the chlorine is oxidised, and a chlorous compound formed from the acid, from which chlorine and water are then liberated by the action of hydrogen chloride. There is reason to think also that the electrolysis of organic acids may, in like manner, involve initially the formation of "peroxidised" products.

All those are questions which require further experimental investigation and consideration. Meanwhile, it is all important to bear in mind how little we really know of such matters. They fall into the same category as the enquiry into the constitution of acids generally, which, I venture to think, must be regarded as still open to discussion, for in scientific work, as in ordinary life, we are much subject to the influence of waves of fashion, and are even apt to be misled by the beauty of a new conception. Faraday taught that the water was decomposed on electrolysing diluted sulphuric acid, and formerly chemists believed that when a metal dissolved in an acid solution it displaced hydrogen from water, and that the oxide thus formed combined with the acid. The binary theory of electrolysis introduced by Daniell in 1839 (*Phil. Trans.*, 1839, 97), however, shook faith in this interpretation; but this theory did not gain full acceptance until after the publication of Williamson's entrancing views on the nature of salts and his discovery of chlorosulphonic acid in 1851-53, from which time onwards the old Berzelian system of representing oxy-acids and their salts was fairly generally abandoned. Yet if we now, without prejudice, calmly review the facts we cannot but admit, I think, that the verdict must still be "not proven." If we, however, in any way return towards the old view, we shall probably have to steer a middle course, and consider that water is not initially active as such, but rather what may be termed combined water. Should a view of this kind ever prevail, especially if it be admitted that in the case of muriatic acid the active substance is a hydrate, $(H_2O)_x(ClH)_y$, the insight and prescience displayed by the older workers, whose minds were untrammelled by the weight of theory, will deserve fuller recognition than is now accorded to them, and Lavoisier's choice of the name oxygen will be more absolutely justified than it has ever been admitted to be since Davy's investigation of chlorine.

The discovery of the nature of the phenomena underlying electrolysis—and therefore those underlying chemical change—may not improbably be assisted by the study of substances other than conducting solutions: and for other reasons also the study of the electrical properties of such substances appears to be of the highest importance.

Thus it is well known that whereas metals generally are relatively good conductors, non-metals oppose a very great resistance to the passage of an electric current. A question of the utmost importance to consider is whether non-metals may not be capable of opposing an infinite resistance, and whether it may not be possible to base on electrical behaviour an absolute distinction between metals and non-metals, although hitherto we have been obliged, on general chemical grounds, to conclude that no line can be drawn, and that, in fact, the metals insensibly shade off into non-metals through the metalloids such as arsenic, tellurium, etc.

As long ago as 1887, in the course of the discussions which took place within the British Association Electrolysis Committee, I drew attention to the importance of making further observations on the specific resistances of the non-metals—pointing out that as these appeared all to behave as electrolytes of very high resistance, it became a question whether this might not arise from the fact that impure substances had been studied, and adding "if sulphur, etc., are found to behave as water—that is, to increase in resistance as they more nearly attain a pure state—then I think we may fairly divide elements into two distinct classes, and define a metal as an element which conducts, and a non-metal as an element which insulates."

The behaviour of sulphur, selenium, and other well-defined non-metals, in fact, is such, that there is hope, I think, that eventually we may be able to draw such a distinction. It is true that Monckmann in 1888, in a paper communicated to the Royal Society on the specific resistance, etc., of molten sulphur, showed that this substance had a not inconsiderable conducting power; and that when objection was raised against the results on the ground that no special care had been taken to purify the sulphur, he extended his experiments, recognising the necessity of obtaining "the purest possible specimens of sulphur," but arrived at results essentially in agreement with his earlier observations. Apart, however, from the fact that the methods of purification he adopted can scarcely be regarded as calculated to afford a "pure" material, and that there is internal evidence in the paper that he was not dealing with a pure substance (it can scarcely be doubted that "pure" molten sulphur would be without action on platinum), it may be noted that only about six months intervened between the presentation of his two papers; had six years been devoted to the task, the conclusion arrived at might, perhaps, have merited confidence.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, April 30.

Dr. J. HOPKINSON (president) in the chair.

ON RAILWAY TELEGRAPHS, WITH SPECIAL REFERENCE TO RECENT IMPROVEMENTS.

BY W. LANGDON, MEMBER.

(Concluded from page 489.)

Staying.—It is no exaggeration to say that to the more perfect manner of staying the telegraph lines of the present day, and to the employment of machine-stranded staying wire, are we indebted for that greater immunity from heavy breaks-down which we enjoy at the present time. It is, in cases of snow, falling under those conditions which cause it to cling to the wires, a question of strength of pole *versus* strength of wire. Needless to say it is preferable the wires, rather than the poles, should suffer; and, as a rule, such is the status at which well-built telegraph lines of the present day have arrived. On railways there is usually more room for staying poles than is the case on roads. The greater the spread of the stay the greater its advantage. In order to be of the greatest service its attachment to the pole should be somewhat above the centre of the full complement of wires which the pole is designed to carry. It is seldom, however, one can determine the number of wires which a line shall ultimately support, and thus it is well to fix that point which may be most serviceable under any condition. The practice pursued by the author has been to fix the upper stay between the third and fourth arm, and where a second stay is required—as is frequently the case with heavily wired lines—between the eighth and ninth. Formerly the practice was to form the stay on the pole, wire by wire. A single wire was first attached to the pole and strained up tightly to

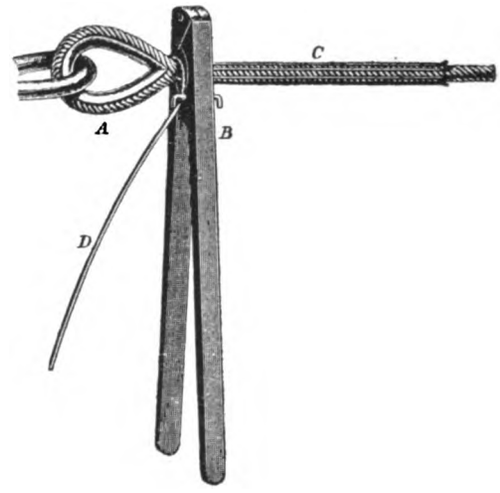

FIG. 4.

the stay-rod; then a second wire was attached and strained up, as nearly as could be judged, to the same degree of tension; and so on, till the necessary strength was attained. The objection to such stays is the absolute improbability of so arranging the several wires of which the stay is composed that each shall bear its share of the strain. As a rule the strain falls upon one wire more than another. Under great stress this wire is the first to give way. The rest follow in like manner. With machine-stranded staying wire each wire bears its own proportion. If properly stranded—*i.e.*, with a long lay—it is easily handled. Where attached to the stay-rod it should be passed around a pear-shaped eyelet. To Mr. W. H. Preece, C.B., F.R.S., past-president, we are indebted for the introduction of machine-stranded wire for this purpose. Staying wire should be of a steely character. The Midland specification provides that each No. 8 gauge wire (which is the only gauge used for stranded staying wire) shall stand a strain of 1,800lb., with a maximum stretch of 4 per cent., without breaking, and that it shall bear 12 twists in a length of 6in. without fracture and without scaling. An excellent device for binding stranded stay wire has recently been introduced by Mr. Roberts, of the Postal Telegraph Department, which enables the workman to accomplish his task well and with ease. The tool itself will be found upon the table.

The strand wire is first bent so as to form the loop around the stay thimble, A (Fig. 4), the splicing tool, B, being employed to draw it closely into the groove. The free end of the stay wire is then unstranded and the wires straightened out, as shown at C. One wire, D, is picked out for the purpose of forming the first lap of the binding. The tool is then employed to arrange the remaining wires symmetrically parallel with and around the main strand so that they may bind into it without

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spoiling its circular shape. The free wire is now placed under the hook of the stay tool, which is revolved around the stay and the remainder of the wires. When the first selected wire has been used up another is chosen, and the same course followed with each until all have been evenly bound around the main stay. All stay-rods planted in soil formed of cinders or ashes should be protected by fillets of creosoted wood, or they will rapidly succumb to the electrolytical action set up by the ashes and the galvanised iron. On railways it frequently happens that the top ballast is composed entirely of refuse cinders or ashes.

Insulation.—For many years a practice has prevailed of using a minor form of insulator for short-circuits or block-signalling wires. The author raises the question whether such a degree of refinement is desirable. It is inconvenient, inasmuch as it does not admit of interchange of wires where such changes are desirable. On the Midland the practice has long been abandoned. But one class of insulator, and one gauge of iron wire—

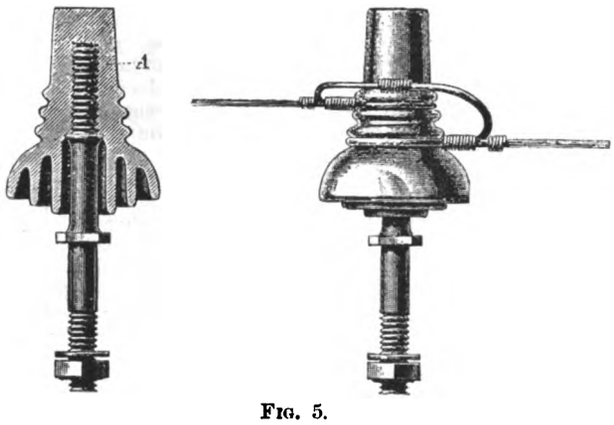

FIG. 5.

viz., No. 8—is employed. Thus, when required, through wires may be joined in with the shorter lengths, and the uniformity of the line preserved by maintaining the shorter lengths below the longer ones. Moreover, it would appear that, however important other wires may be, none can be more important than those which govern the movements of the trains. It is believed that the best insulators are those known as the "Post Office" and the "corrugated," samples of which are on the table. Samples of the form of terminal insulator and leading-in cup, employed largely by others as well as by the author, are also before the meeting. The terminal insulator is made in two sizes, the smaller kind being employed where the strain is small, as, for instance, for leading across from one side of the line to the other for signal-box and other like purposes. The larger kind is employed for terminations of line wires. The great advantage of this insulator resides, not merely in the shape of the ware, but in the extent of the bolt, A (Fig. 5), which, it will be seen, passes far beyond the corrugations at which point the line wires are attached—a provision which renders it practically impossible for a wire to fall, even when the porcelain

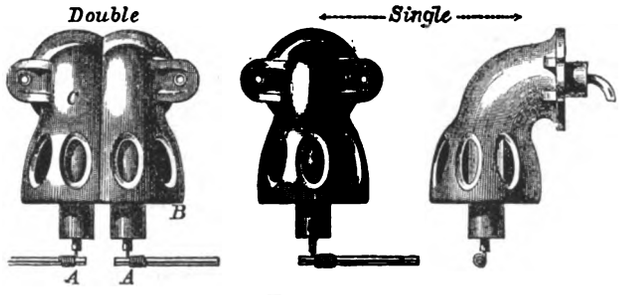

FIG. 6.

is from any cause broken. Another advantage is that these corrugations, or grooves, not only help the insulation, but make provision for the attachment of different gauges or different descriptions of wire, as, for instance, if it is desired to attach a No. 11 to a No. 8. If the No. 8 is placed in the lower groove, and the No. 11 in the upper groove, the strain on the bolt will be about equalised, and the insulator will retain its vertical position. They are equally useful for joining two descriptions of wire—say, iron and copper—the one being terminated on one ring, and the other on another, the two wires being joined by a loop. At the termination of all important wires, and, in many instances, at important signal-boxes, "leading-in" cups are employed. They are formed (Fig. 6) of a porcelain tube, A, in which the G.P. wire is threaded, the tube being contracted at B, so as to keep the wire central and free from the edges of the tube. This tube is protected by an iron hood, C, perforated, so as to admit of the rain cleansing the porcelain tube. Where round creosoted poles are employed for leading-in wires, it is necessary to carry the G.P. wires in boxing fixed between the arms. If this boxing is strongly made, it will admit of the leading-in cups being fixed to either side of it, and will thus form a very complete and durable termination.

Wire.—Considerable progress has of late years been made in the employment of copper wire. The first copper wire erected for telegraph purposes was, it is believed, that erected by Mr. A. Graves, of the North-Eastern Railway, at York, about 1877. Mr. Graves on that occasion employed No. 14 gauge (·080 S.W.G.), and shortly afterwards, in 1880, copper wire of the same gauge was erected on the Midland. The copper wire of various gauges in use on the Midland now extends to some 5,000 miles, of which 3,000 odd is maintained for the Post Office. The objection to iron wire is the shortness of its life, and—in comparison with copper—its higher electrical resistance and greater inductive capacity. Under the auspices of the Post Office a class of iron wire largely superior to that formerly in use has for some years past been obtainable. This improvement—embracing conductivity and the general construction and character of the wire—does not, however, extend to prolongation of life. In a few years, more or less, dependent very much upon the condition of the atmosphere, the galvanising is gone, rust sets in, and thereafter the strength of the wire, as also its conductivity capacity, rapidly degenerates. Covered iron wire is frequently found to be of great service in smoky localities. The best is that served with what is known as "West's compound." The wire is lapped with cotton, and

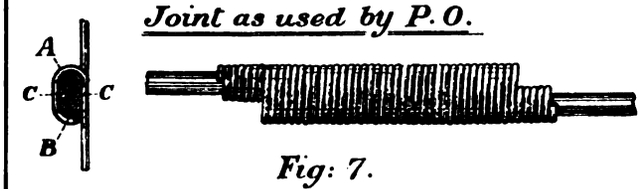

Fig: 7.

then passed through a special liquid composition, so that the cotton covering may become saturated by it. It differs from all other covering processes in that the composition hardens when exposed to the air, is unaffected by changes of temperature, and when hardened is impervious to wet. So long as the covering remains sound the wire beneath it retains its original condition, and when the covering is removed appears as fresh as when new. A sample of some of this wire which has been in use on the Midland for some years will be found on the table. The conductivity resistance of a 12½ gauge (·097) copper wire is 5·934 ω per mile; that of No. 8 (·160) gauge galvanised iron wire is 12 ω per mile. The breaking strain of the 12½ copper is 409lb.; that of No. 8 galvanised iron, 1,100lb. The cost of a mile of 12½ copper is about £4. 4s.; the cost of a mile of No. 8 galvanised iron wire, £2. 10s. The difference in price is considerable, but against this we are able to place many advantages: durability—which means less cost in renewal, a saving of certainly two out of three, which at 20s. a mile more than covers the additional cost; reduced strain, and less load on poles, which admits of their reception of a greater number of wires; and last, though not the least important, less liability to

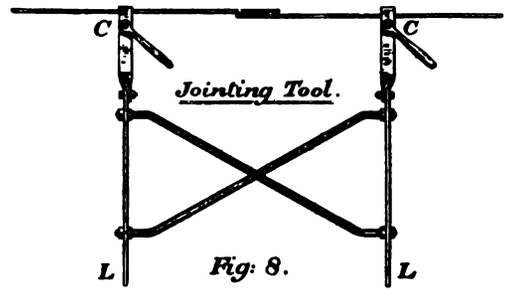

Fig: 8.

fracture. It is probable that 12½ copper, or possibly a slightly larger gauge, will entirely supersede galvanised iron wire; for, although when new the galvanised iron wire has the advantage in tensile power, it retains that power a portion of its life only, and during the latter part of its existence its tensile strength is even less than that of the 12½ copper. Its electrical resistance is, even when new, more than twice that of the copper wire. It is desirable in using 12½ gauge copper wire, where possible, to slightly reduce the length of span—to limit it to 70 yards on the curve and 75 on the straight—say 24 poles to the mile, instead of 22. In all newly constructed lines for the Midland Company's own purposes, copper wire is now used; and in the renewal of existing wires, iron is, as a rule, being replaced by copper. In the erection of either copper or iron wire, the degree of tension to which the wire is pulled up is a factor which plays an important part in its durability. Wiremen, until they are taught otherwise, have a profound contempt for the

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effect of temperature upon the material they are using. On a hot summer day, or a bleak winter morning, they will pull the wire up to the same degree of tension. The consequence is that the wire erected under its maximum expansion in the hot noontide is either broken or stretched under the influence of a lower temperature. The dip, or the stress, imparted to a wire must always be governed by the temperature, for which purpose a thermometer, placed in a position analogous to the wire, must be used. Where wires are run on the parallel system, if the top wire is erected to the required degree of tension, the eye of the wireman can by it readily regulate other wires in the same span. To impart to this wire the proper degree of tension its stress must be determined by its "dip," or by what is known as an indicating tension-ratchel, the latter by preference. Where wires are erected on the "revolving" system, it is impossible to avoid the use of the tension-ratchel if the wires are to enjoy a uniform degree of tension. To Mr. W. H. Preece, C.B.,

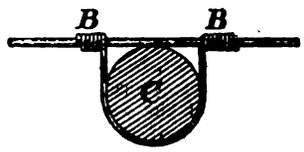

Fig: 9.

F.R.S., we are indebted for much careful investigation of this important question, and by his courtesy I am enabled to add, in the appendix to this paper, tabulated statements adopted by the Post Office showing the stress at which both copper and iron wires should be erected at various temperatures.

Jointing.—The "Britannia" joint still holds its own, whether for iron or copper wire, but the ends (or "tails"), which for years have been left bent up, are now cut clean off, it being evidently better for a joint to *draw* than to form an intermittent fault. The Post Office, with regard to copper wire of large gauge, before soldering, fill the interstices between the two wires, A, B (Fig. 7), and the binding by two pieces of smaller gauge wire, C. The object is to facilitate the soldering of the joint, and so prevent overheating the copper. The joint when completed is wiped clean, and allowed to cool. It should not be overheated, and it should not be chilled. Where joints are made in this manner, a jointing frame becomes necessary. This consists merely of a couple of clips, C, C (Fig. 8), in which the ends of the wire are held. It can with convenience be fixed by the legs, L, L, to the wiring barrow, or the legs may be thrust into the ground; and here, perhaps, although a minor matter, it may not be out of place to call attention to an improved "wiring barrow" which has recently been brought into use. These barrows are made with a frame similar to that of a garden barrow, but longer. The drum for the reception

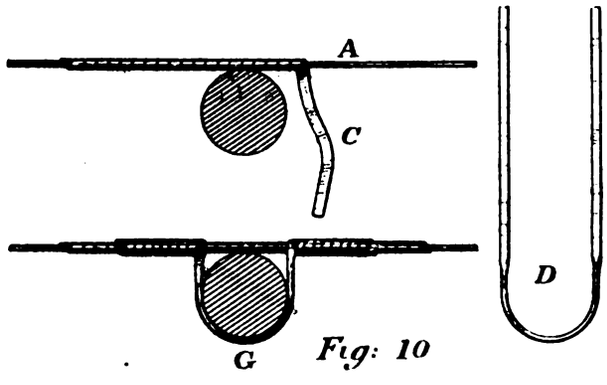

Fig: 10

of the wire is made of sheet iron, and works vertically, instead of horizontally as hitherto. Ordinarily the barrow is wheeled along the sides of the line by one man, as on a public road; but where it cannot be wheeled, two portable arms, provided for the purpose, are placed in position, and the barrow is then carried in the usual manner by two men. The arrangement will be understood by reference to the photographs on the table.

Binding.—For many years the author has abandoned the use of No. 16 galvanised iron wire for binding, and has employed in its place a specially made No. 11 galvanised iron wire. It is necessary this class of binding wire should be more ductile than the ordinary conductivity No. 11 galvanised iron wire, and that it should be capable of being lapped around a No. 8 wire without scaling. If it scales it will rust, and the oxide will be carried by the rain down the outside of the insulator cup, to which it will adhere to such an extent as may in damp weather materially affect the insulation of the wire. In Fig. 9, C represents a cross-section of an insulator at the point at which the binding wire is attached. The binder is merely lapped some five times around the line wire, as shown at B. It will be found that this form of binder will prevent a broken wire from running back quite as well as any form of binding with No. 16 gauge wire. Its advantages are great durability, absence from stretch under influence of gales, less cost in construction and maintenance, and greater freedom from chafing, the line wire being much more firmly held. The practice thus pursued by the author has in a modified form been adopted by the Post Office with respect to copper wire. That portion of the line wire, A (Fig. 10), which rests against the insulator, B, as well as the portion which is to be lapped by the binder, is first overlaid by a copper tape, C, a piece of copper wire rolled out flat. The binder, D, is formed of a large gauge wire which has its two ends flattened so as to be readily laid around the taped portion of the line wire. Both the tape and the binder are first laid on by hand, the copper strip being exceedingly ductile, and finally tightened by the aid of a suitable pair of pliers, the complete binding being as shown by G

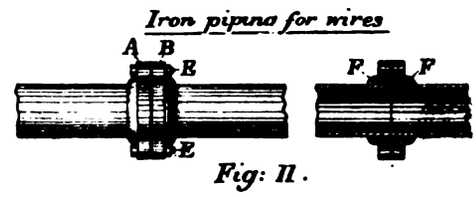

Fig: 11.

(Fig. 10). Samples of these binders and tapes, as well as of the complete form of binding, are on the table. The author is of opinion that wherever a sufficiently ductile wire can be obtained for the purpose it is better to employ a binder of a gauge equal, or nearly so, to that of the line wire. The Post Office, under the direction of the engineer-in-chief, have recently issued tables of sizes, weights of tapes, and binders for the different gauges of copper wire, which, by Mr. Preece's permission, I have the privilege to append to this paper.

Guttapercha and Covered-Wire Work.—It is believed there is very little to record in the matter of guttapercha-covered wire. In making it a practice to use ozokerite taped wire in all instances for underground work, or for wooden casing, it is probable the author is merely following the practice of others. The taping adds very little to its cost and very largely to its life. The number of wires which are now required for signalling purposes—the fact that, as a rule, the "leading-in" pole is placed in the rear of the signal-box, while the instruments are invariably arranged over the signal lever frame in the front of the box—leads to a large consumption of guttapercha-covered wire, and renders it all the more necessary that every precaution should be adopted to preserve the life of the insulation. To this end all G.P. wires should be boxed in, and the boxing (which should be grooved from the solid), when carried underneath the floor of the signal-box, should be inverted, so that any moisture from the washing of the floor of the signal-box may not penetrate the boxing and impair the percha. The author has for some years employed wire covered with indiarubber, plaited cotton, and compound, for signal posts. It withstands the heat much better than G.P.; the conducting wire is less liable to become decentralised; and he has good reason to believe that it will prove very durable. Although instances have arisen where armoured cables composed of from

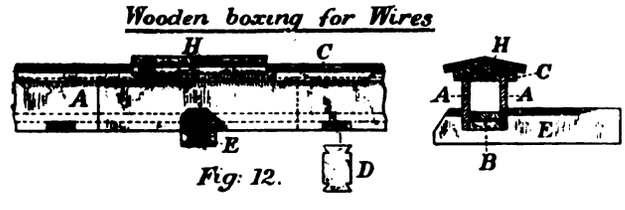

Fig: 12.

three to ten conducting wires have been employed for telegraph and signal purposes, it cannot be said such are in general use. In station yards, where the wires are generally laid underground, and in other equally crowded places, armoured cables for odd lengths will probably be found not only useful, but, in order to avoid disturbing the body of through wires, a necessity. Such cables are extremely useful for crossing the line of railway for repeater or similar purposes, where, unless the wires are carried underground, a large alteration is necessary in the poles in order to carry them overhead. In laying down some underground work at Leicester and Nottingham, a simple form of cast-iron piping, which, having an indiarubber joint, is very quickly placed in position, has been used. It is inexpensive and readily handled. An illustration of the joint will be found in Fig. 11. A B are clamps which slide over the pipe, D, which is merely a straight tube. A B are recessed at A' B' so as to receive the small piece of tubing, C, together with an indiarubber washer, at either end. The pipes, D, are laid out so as to meet at C. A and B, as well as C, are then slipped on, the tube, C, is brought into its proper

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position, and A and B are then closed up and tightened by the bolts, E. The indiarubber washers afford a firm grip, so that the pipes, D, are not readily drawn apart. The arrangement is better suited for level ground than for heavy slopes. Fig. 12 represents a form of wooden boxing for tunnels and wall work. It is the production of my inspector carpenter, Hobday, and is set together and maintained in position without the aid of a nail or screw. It is formed of four pieces of wood. The side pieces, A A, are grooved to accept the bottom board, B; the top, C, is grooved to accept the side pieces; the two sides are held together by tie-pieces, D, inserted at intervals of 3ft. Instead of iron supports, wood blocks, cut from flawed or otherwise unsatisfactory oak arms, are shaped as shown by E to receive the boxing. These supports are fixed in the masonry by wood wedges or cement 6ft. apart. A piece of wire passed around the support and the boxing holds the entire structure safely in position. No two pieces of wood from which the boxing is composed terminate at the same point, with the exception of the lid. At the junction of these pieces a wooden capping, H, is employed to cover the seam.

Instruments.—In telegraph message instruments the vertical handle "single needle" remains that generally used in Great Britain. For some years it has been the practice on the Midland to employ, at the transmitting or terminal station of all busy single-needle circuits, a "Bright's Bell" in place of the single needle—an arrangement which will be found to aid dispatch and lighten the labour of the clerk. The Bright's Bell is also largely used by the Great Northern between telegraph offices. The Lancashire and Yorkshire and the Great Eastern employ it on single-needle circuits in a similar manner to the Midland. Although the "sounder" is very generally employed for railway message work in Ireland, it cannot be said to have taken root on English railways. For direct and long circuits it is occasionally used, but it is believed not to any great extent.

Fig: 13.

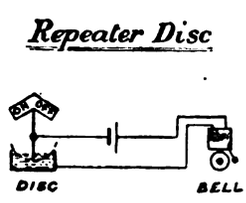

Fig: 14.

For "quadruplex" working the demand does not appear to have been very urgent. It is employed by Mr. Hollins on the Great Eastern, between London and Harwich. "Duplex" working is employed on the Great Eastern, Caledonian, London and South-Western, and London and Brighton, and on the Midland. On the Midland a duplex circuit between Derby and London also provides for a phonopore communication. The phonopore is employed to a very limited extent on the Midland, Great Western, Great Eastern, Brighton, and North British lines. Telephones, as was to be anticipated, are now very generally employed for *viâ voce* communications between signal-boxes, and at busy centres between the administrative offices. That their employment largely aids the disposal of traffic there can be no question. At many points, and under exceptional conditions of weather, they are invaluable. On the Continent, as well as at home, serious rumours have from time to time, arisen with respect to the dissemination of disease by means of these instruments. It has been contended that a person suffering from throat or other internal affection, on speaking into a transmitter, may leave in the interstices of the instrument germs of the disease, which may be inhaled by others using the same instrument. Fig. 13 represents a transmitter which has been designed with a view to obviate any such evil effect. The ordinary mouthpiece is removed, and in its place the entire face of the instrument is covered by a diaphragm, A, made of wood or metal—the former by preference—which encloses an air space, C, between it and the ordinary or electrical diaphragm, B. On speaking in the neighbourhood of the outer diaphragm its vibrations are transmitted by the pressure of the enclosed air to the electrical diaphragm. Speech is marvellously clear, and only when used for long-distance telephony—as between London and Glasgow—is any diminution in the sound noticed, and then only in a very slight degree.

Block-Signalling Instruments.—The practice of arranging the block-signalling instruments apart from the signal frame has with most companies been abandoned. As a rule, all block apparatus is now fixed on a shelf immediately over the signal frame so that they may be readily manipulated by the signalman, and their indications remain present to his view. With the exception of the introduction of Tyer's tablet block, and Messrs. Webb and Thompson's electric staft for working single lines, there is little of novelty in block instruments to record. Interlocking the electric with the mechanical signals has made but little progress. The mileage of railway lines in Great Britain (see Table A) worked under the absolute block is 26,398. A very small fraction of this has the electric signals interlocked with the mechanical signals. It appears almost marvellous that the enormous traffic which now passes over our railways should be conducted with so few casualties under an arrangement which entails a perfectly independent action for both the electric and the mechanical signals. The former are provided for the regulation of the traffic between signal-post and signal-post, but where they are not interlocked with the mechanical signals, which are those which actually guide the engine-driver, they merely indicate to the signalman how he is to work his signals; they in no way control them. That so few casualties arise testifies in the highest degree to the care and watchfulness

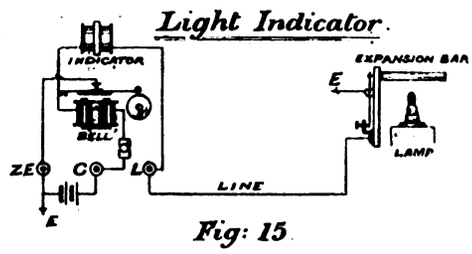

Fig: 15.

exercised by the signalmen to whom falls the duty of working the traffic under such conditions. The subject is one which may well lay claim to further consideration at the hands of some member of this Institution. In the meanwhile, it may be desirable to point out that the interlocking which has, so far, been employed is still wanting in finality. As now used it is the first vehicle which releases the lock. Needless to say, it should be the last. Electric "signal repeaters" and "light indicators" have become indispensable adjuncts. On the Midland there are no less than 3,000 of the former and some 800 of the latter in use, and with many other companies the number is no doubt as large. Another useful adjunct is that termed the "repeater disc," employed to indicate the movement of the lever of "slotted" signals. It differs from the signal repeater in that the indicator when passing from the "on" to the "off" indication directs the signalman's attention to the alteration by ringing a bell (Fig. 14). "Light indicators" should be so constructed that they may indicate any failure in the light by a continuous ringing of the bell. The entails the maintenance of the "Light in" signal by permanent current. Two No. 1 Leclanché work the instrument perfectly well. Fig. 15 is a diagram of the connections. Fig. 16 is a diagram of the signal repeater arrangement, the batteries being placed at the signal-post. The "on" contact, B, is fixed, and the contact which the tongue-piece, A, makes with it is only

TABLE A.—Extract from Board of Trade Returns, Year ending December 31, 1894.

—	Total length of railway open for passenger traffic.		Distance worked by absolute block.			
				Distance of single line.		
	Double.	Single.	Double line.	Worked by train staff system in addition.	Worked without the train staff system.	Worked on electrical train staff or tablet system.
	m. ch.	m ch.	m ch.	m. ch.	m. ch.	m. ch.
England and Wales	9,281·49	4,376 55	9,266·69	2 263·18	42 39	1 680·66
Scotland	1.289 09	1 761·00	1,287·19	222·04	119·43	961·61
Total for Great Britain.....	10,570·58	6,137 55	10,554·08	2,485·22	162·02	2,642·47
Ireland	613 00	2,414·52	613·00	451 09	0·70	1,555·51
Total	11,183·58	8,552·27	11,167·08	2,936·31	162·72	4,198·18

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APPENDIX.—Post Office Tables for Stresses to be Observed in Erecting Copper Wires at Various Temperatures

Temperatures in degrees F.	Stresses in pounds for various spans in yards.																			
	150lb. per mile. (97 mils diameter, No. 12½ S W G.)					200lb. per mile. (112 mils diameter, No. 11½ S.W.G.)					400lb. per mile (158 mils diameter. No. 8 S.W.G.)					600lb. per mile. (193 mils diameter, No. 6 S W.G.)				
	50 yds.	60 yds	70 yds	80 yds.	90 yds.	50 yds	60 yds.	70 yds.	80 yds.	90 yds.	50 yds	60 yds	70 yds.	80 yds.	90 yds.	50 yds.	60 yds.	70 yds	80 yds.	90 yds.
	lbs.	lbs	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
22	120	120	120	120	120	160	160	160	160	160	320	320	320	320	320	480	480	480	480	480
25	96	102	106	109	111	129	136	142	145	148	258	272	284	290	296	386	409	425	436	444
30	76	84	91	96	99	102	113	121	128	133	204	226	242	256	266	306	338	364	383	399
35	65	74	81	86	91	87	98	108	115	122	174	196	216	230	244	262	295	323	346	365
40	58	66	73	79	84	77	88	96	106	113	154	176	192	212	226	232	265	294	318	338
45	52	61	68	74	79	70	81	90	98	105	140	162	180	196	210	211	243	271	296	317
50	48	56	63	69	75	65	74	84	92	100	130	148	168	184	200	194	223	253	277	299
55	45	53	59	65	71	60	70	79	87	94	120	140	158	174	188	182	211	238	262	284
60	42	50	56	62	67	57	66	75	83	90	114	132	150	166	180	171	200	226	250	270
65	40	47	53	59	65	54	63	71	79	86	108	126	142	158	172	162	189	214	238	260
70	38	45	51	57	62	51	60	68	76	83	102	120	136	152	166	153	181	205	229	249
75	37	43	49	55	60	49	58	66	73	80	98	116	132	146	160	147	173	197	220	240
80	35	41	47	53	58	47	55	63	71	77	94	110	126	142	154	141	166	190	212	232
85	34	40	46	51	56	45	53	63	68	75	90	106	122	136	150	136	160	183	205	225
90	33	39	44	49	54	44	52	59	66	73	88	104	118	132	146	131	155	177	199	218
95	32	37	43	48	53	42	50	57	64	71	84	100	114	128	142	127	150	172	191	212
100	31	36	42	47	52	41	48	56	62	69	82	96	112	124	138	123	146	167	188	207
Poles per mile.	35	29	25	22	19½	35	29	25	22	19½	35	29	25	22	19½	35	29	25	22	19½

sufficient to a movement of 2deg. The contact, C, is adjustable. Samples are on the table.

Batteries.—To the bichromate and Leclanché battery the author ascribes the palm of merit for a good and useful battery for railway purposes. For hard and constant work the former is unsurpassed. For occasional purposes and for constant action, under certain limitations, the Leclanché commands attention. The old form of Daniell (sulphate) of copper battery, it is assumed, no longer finds a profitable field in railway telegraph work. The Leclanché-Barbier cell is the latest development of the liquid Leclanché type of battery. It differs from the preceding types in the form of the positive element, together with other mechanical details. The positive element consists of a hollow cylindrical agglomerate of carbon and peroxide of manganese, around the upper part of which is cast a metal ring, caused to fit the neck of the jar, between which and the metal ring an indiarubber washer is inserted. The centre of the cylinder is covered by a wooden block, which serves to support the zinc and to close the jar. There is thus little possibility of evaporation; the cell is practically hermetically closed, and is in every way satisfactory.

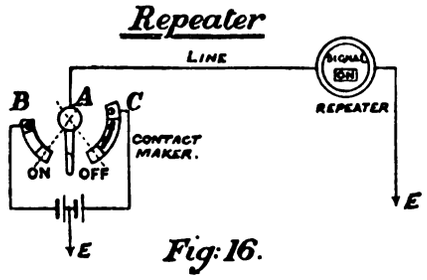

Fig. 16.

The most recent innovation in batteries is the so-called "dry cell," but of them the author cannot profess to any lengthened experience. In their early days they were frequently disappointing and unreliable. Much of that has now been remedied; yet it is doubtful if their employment on railways would be economical, for it would still be necessary to retain linemen and battery men, or assistant linemen, to attend to failures of instruments, etc., when such arose. General freedom from such failures would in no way modify this demand for the presence of the lineman. Failure at some time would be certain to arise. Whenever it did, the lineman must be there promptly to attend to it, or the traffic would necessarily suffer. I feel that, in submitting to your consideration so lengthy a paper, I have largely encroached upon your time and patience. It has, however, been impossible for me to deal with the subject in less space, and equally impossible to divide it into two parts. I believe that you will, under these circumstances, generously accord me your kind indulgence. As it is, I fear I may still have omitted some points of interest; and that, possibly, a want of knowledge of that which has been, or is being, done by others may even now render my treatment of the subject incomplete. Where such is the case, I must trust to my *confrères* to supply any such deficiency in the discussion which the paper may elicit.

APPENDIX.—Post Office Tables for Stresses to be Observed in Erecting Iron Wires at Various Temperatures.

Temperature in degree F.	Stresses in pounds for various spans in yards. 200lb. per mile (121 mils diameter, No. 10½ S.W.G.).					400lb per mile (171 mils diameter, No. 7½ S.W.G.).				
	50yds	60yds	70yds	80yds	90yds	50yds	60yds	70yds	80yds	90yds
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs	lbs.
22	135	135	135	135	135	270	270	270	270	270
25	120	124	127	128	130	239	247	253	256	259
30	103	110	115	119	122	205	219	230	238	243
35	91	100	107	112	115	182	199	213	223	230
40	83	92	99	105	110	165	184	198	210	219
45	77	86	94	99	105	153	172	187	199	210
50	72	81	89	95	101	143	161	177	190	201
55	67	77	85	91	97	134	153	169	182	194
60	64	73	81	88	94	127	146	162	175	187
65	61	70	78	85	91	121	139	155	169	181
70	58	67	75	82	88	116	134	149	163	175
75	56	64	72	79	85	111	129	144	158	170
80	54	62	70	77	83	107	124	140	153	165
85	52	60	68	75	81	103	120	135	149	161
90	50	58	66	73	79	100	117	132	145	157
95	48	56	64	71	77	97	113	128	142	154
100	47	55	63	69	75	94	110	125	138	150
Poles per mile	35	29	25	22	19½	35	29	25	22	19½

Factor of safety of 4 at 22deg. F. for all wires. The stress varies with both the gauge and the material. The stress for 100lb. (No. 14) copper wire is half that for 200lb., and the stress for 800lb. (No. 4½) copper wire is double that for 400lb.

APPENDIX.—Post Office Tables for Copper Tape Binders.

Weight of wire per mile			Length of binder.	Copper tape	
Line	Approximate gauge.	Binder.		Length.	Width.
lbs.		lbs.	inches	inches.	inch.
800	4½	400	19	24	¼
600	6	400	19	24	¼
400	8	200	19	23	7/32
200	11½	150	17	22	7/32
150	12½	150	17	22	7/32
100	14	100	17	22	7/32

Discussion.

On the conclusion of his paper **Mr. Langdon** remarked that he had received a letter from Mr. Graves, of the North-Eastern Railway, who wished to make a correction. The first copper wire he

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erected was a short length at Gateshead in July, 1871. He (Mr. Langdon) had also received a letter from Mr. Preece on the same subject. Mr. A. Graves was not the first to erect copper wire, because all the very early lines erected in England were of copper—the Paddington and Slough line, for example. In more recent times the great start in the use of copper was when he (Mr. Preece) induced Mr. Patey to put up a copper wire between London and Newcastle. The Post Office also introduced copper wire for the telephonic service.

The reading of the paper was not concluded till past nine, and the **President,** before the discussion was opened, remarked that as they had only two more meetings, and papers for each of them, it was absolutely necessary to furnish the discussion of Mr. Langdon's paper that evening. Gentlemen who had written remarks would hand them in to the secretary for publication.

Mr. Wyles, who opened the discussion, remarked that, so far as concerned the progress of electrical interlocking, the congested traffic out of London, at all events so far as affects the railways on the southern side, was completely interlocked. He might mention the work done on the South-Western, at Cannon-street Station, on the South-Eastern Railway, and on the London and Brighton and also on the Great Eastern lines. On his own line (the London and South-Western) they had a good many cases in which the signals were thrown to danger electrically, and complete electric interlocking was fitted between Waterloo and Esher on the main line, and as far as Twickenham on the Windsor branch, and the system was being extended. The whole of the Chatham and Dover Railway and the District was also electrically interlocked by the Sykes system. Besides this, he might mention that he had also working on single lines electric interlocking, whereby the starting signal could not be lowered unless the tablet was previously drawn. This system was patented by Mr. W. R Sykes, and worked out in conjunction with the speaker.

Mr. C. Goldstone said that, in reference to what had been said in the paper as to duplex working, he thought that South-Western must be a slip for North-Western. They had not got it on their line, but on the South-Western he might say that they had something like 150 miles of electrical interlocking, and he expected by the end of the year about a third of the line would be electrically interlocked—certainly all the busy portions would. At no period of his experience of block signalling had there been greater activity than at present, especially in the direction of interlocking, which was making great progress.

Mr. Spagnoletti took exception to the system of poles in Figs. 1 and 2. If one of the poles sunk, there would be a hinge action on the other. The cross-pieces would stop that and the cross-arms to a certain extent, but it would cause a heavy strain on them. His practice was to put flat pieces at the bottom of the poles, which gave a firm foundation. With reference to staying, he had found that the heads of the bolts pulled through when the stay blocks got rotten. To obviate that he had introduced a cast-iron plate. He had not done much with iron arms, so could not speak of them; nor had he always earth-wired the arms. Stays were very important in case of snowstorms. He had had as much as 40 miles of posts down from snow. The difficulty was when the snow adhered to the wires and increased on them until they grew together. Then the wires broke on one side, and down went the pole from the pull on the other. He therefore had stayed the poles on both sides. He could not see why in open country iron wire should not be used. Mr. Langdon seemed much to prefer copper. As to iron not lasting in country wires, with a pure atmosphere he found that they simply did not know the life of them. They had had some up over 35 years. If they looked at the list of instructions and cautions issued by the manufacturers to be observed in putting up copper wires, it would be almost enough to frighten them. The terminal insulator shown was a good form, but the strain was not equalised as it was in the shackle, and it might therefore pull over. There was no advantage over the shackle in case of the earthenware getting broken, as the wire was held by the metal in both cases. Leading-in cups were excellent things, but they were not new. Mr. Latimer Clark had introduced them many years ago. As to the life of wires, it all depended where they were fixed. In some parts of South Wales, for instance, it was very short—not more than 3½ years. He had found that an excellent coating for wires was made by heating them and dipping them in boiled tar, and he referred to the experience of wires between Wolverhampton and Birmingham (a bad district) which had been treated in this way. The worst of all coverings was that they were liable to be damaged in putting up. The grip of the vice would do this, so that the wire had to be painted afterwards at places so damaged. As to electrical interlocking, it had been adopted on the Metropolitan Railway, and also for protecting trains when on their wrong lines and in crossing over. Iron tubing he did not like for crossing work, as he found that workmen were apt to break the pipe with their picks. It was better to use wood, in which the pick stuck fast, and made the workman see he was going where he should not. With reference to the telephone, using the phonopore there was no difficulty in holding a conversation and working the telegraph wire simultaneously.

Mr. C. Bright asked the author of the paper why it was the custom to use guttapercha instead of indiarubber as a covering for wire, and what was the advantage of keeping the former dry.

Mr. R. von Fischer Treuenfeld was pleased to hear that at least one branch of telegraphy—he referred to interlocking—was still wanting in finality. It had been stated by some that the sphere of telegraphy had been worked out. On the contrary, he believed that there was still plenty of room for intelligence and skill in its development. On the subject of iron telegraph poles, these had been much employed in the Colonies. But iron telegraph poles of certain dimensions did not now seem to be able to stand the strain that they did 25 years ago. The makers might, perhaps, be able to explain that. Moreover, they had now to carry more wires than formerly. Most poles were made with a wrought-iron top and a cast-iron base, and it was at the joint that the weak point occurred. Mr. Siemens, to obviate this, had designed a pole in which the wrought-iron top was carried down into the cast-iron base. As to copper wire, he (Mr. von F. Treuenfeld) was well aware of its advantages. Its smaller capacity, and consequently greater speed, might amount to an advantage of 25 per cent. But there was another side to the shield which was not so bright, and that was the very poor breaking strain of copper wire In case of snow and wind, iron would have a considerable reserve of strength remaining when the breaking point of copper wire had been already exceeded. Further remarks he would hand in for publication.

Mr. Langdon replied briefly to the various speakers. It was unfortunate that the meeting of the Institution clashed with the date fixed for the committees of many of the railway boards, and consequently several gentlemen connected with the railways were unable to be present. As to what Mr. Wyles had said, interlocking was no doubt making progress, particularly on the South-Western and Great Eastern Railways, but he thought it a matter of regret that the companies in undertaking it had not dealt with it in a final manner. At present a train entering a section puts on the block signals, which control the section; but if the train happens to be, divided, the first vehicle which passes over the point of redress enables the signalman to clear the line. The system was not a perfect or final one. The only plan was to make the release of the signals dependent on something attached to the last vehicle. With reference to what Mr. Goldstone had said to duplex working on the London and South-Western, he would look into the mistake and correct it. Mr. Spagnoletti had taken exception to the H poles. He had probably overlooked the diagonal block that was provided specially to prevent the scissors action that Mr. Spagnoletti feared would occur. Of course, with the double pole in the second figure there was nothing to prevent the sinking of one pole, and that was why he had enforced the necessity of letting the second pole stand for some time before arming it. After all, the proof of the pudding was in the eating, and he had had some hundred miles of poles on this plan without the difficulty occurring. He thought the bottoms must be very rotten if the stay bolts pulled through. If creosoted, they would not rot. Lateral staying had not been mentioned in the paper, but he had used it for many years. It was done at every tenth pole whenever the wires on the poles exceeded 20. He must congratulate Mr. Spagnoletti on having a district where wires lasted 35 years. The difficulties mentioned in erecting copper wire he had not found arise in practice As to the question of shackles or terminal insulators, the shackle no doubt took the strain better, but it was not nearly so good an insulator. Referring to the tarring of wires, he imagined the preservative value of the tar lay in the oil it contained. When this evaporated, the sediment that was left would not give much protection. He had used the phonopore to a limited extent, and if Mr. Spagnoletti could arrange to dispense with the induction they got from it, it would be an excellent instrument. In reply to Mr. Bright, he thought indiarubber became somewhat plastic on exposure to the air. If the guttapercha could be always kept in water it would be all right, but it could not, and when it became porous the access of water destroyed the insulation. Iron poles, if large enough to give the strength required, were too expensive. In reference to what Mr. von F. Treuenfeld had said as to the behaviour of copper and iron wire in case of snow, curious as it might seem, experience had shown that there was little difference between them.

The **President,** in conveying a vote of thanks to Mr. Langdon for his paper, said it had long been somewhat of an opprobrium to the Institution that they had had no papers from railway telegraph engineers. Mr. Langdon, with his excellent paper, had been instrumental in removing that opprobrium, and had done so under very considerable difficulty owing to ill-health.

The next meeting is on May 14.

STEAM SUPERHEATING.

It will be remembered that Mr. Patchell's paper "Notes on Steam Superheating" was the last one read at the meeting of the Institution of Mechanical Engineers on January 31, and the discussion on it was adjourned. This was resumed at the meeting on the 29th ult.

At the outset, **Mr. Patchell** remarked that a certain form of superheater he had alluded to as that of Messrs. Hick, Hargreaves, and Co. was really the work of Messrs. Musgrave, of Bolton. He might also say that the fan draught used at the Maiden-lane station was not greater than that of many factory chimneys. As to his not having given any opinions in his paper, he had understood that it was facts that were wanted rather than opinions.

After a description of an experimental engine by **Mr. E. Perrett,** **Prof. Unwin** remarked that as for the question of facts or opinions, there were any amount of the former on record. What was now wanted was an adequate theory. Although the vast mass of experiments made in England and on the Continent had shown that superheating was economical, the system had not been generally used because engineers had not understood the principle of it. They might use steam in three ways—that is, they might use ordinary boiler steam, which was

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always wet; or moderately superheated steam, which was wet in the cylinder; or, again, highly superheated steam. This latter was, so far as he knew, only used by Mr. Schmidt in Germany. With moderate superheating, say 120deg., all the additional heat was used to warm the cylinder, and might be taken in place of jacket heat. Although what had been said about Trevithick's report of 1828 might be true enough, the practical value of the discovery of the use of superheated steam should be attributed to Hirn in 1855. The great defect in Mr. Patchell's paper was that it mixed up engine and boiler economies. Nor had he always given sufficient information to show whether the advantages claimed were really due to superheating. In all boilers the largest waste was the chimney waste. It might fall to 20 per cent., but was always the most considerable. Details as to this were wanting, but it appeared that in two cases compared the chimney waste was not the same If the McPhail and Simpson superheater was really a superheater, it was so rather by accident than by design. Of the trials quoted only those of Prof. Kennedy were at all complete, and in these the superheat at the engine was only 7deg. There was apparently a boiler gain of as much as 1lb. of water evaporated per pound of coal, but from the table it appeared that the temperature of the gases on leaving the boiler was 309deg. F. without the superheater and 376deg. when the superheater was used. Consequently the boiler could not have been working in the same way on each occasion, and he suspected that the air supply was not the same. In two or three other trials mentioned there was no means of ascertaining the ratio between the heating surface in the boiler and the superheating surface. His opinion was that the apparatus of Hirn, as used in Alsace, was the one that would come into use. If the superheaters were properly designed and placed, there was no necessity for a special device to regulate the temperature. The up take of the funnel was not the right place. In most cases a properly-designed superheater would give 15 to 20 per cent. gain.

Mr. Phillips mentioned that he saw a superheater in a steamship in 1851, though it was not used. The system was given up about 1878. The credit of introducing superheating belonged to an American—Wetherhed.

Mr. Bryan Donkin agreed that regulation of the degree of superheating was not important. The reason superheated steam was more economical than saturated steam was because cylinder condensation was reduced. The locomotive engineer had not tried superheating, and the marine engineer seemed only to remember the failures of years ago, which were really due to bad material and unsuitable lubricants. A good commercial thermometer was wanted to ascertain the temperature of the steam.

Mr. Burstall described some thermometers designed for Prof. Kennedy at the Edinburgh electric light station. With mercury thermometers errors of from 30 to 50 per cent. occurred. The thermometer he referred to consisted of two coils of fine platinum wire wound on mica strips, and the temperature was obtained from the resistance.

The discussion had to be adjourned to May 1, when a further contribution to it was made by **Mr. Geipel.** That gentleman did not think that superheating should be employed indiscriminately—at any rate, to such a high limit as had been mentioned for all purposes—without first weighing thoroughly the advantages against the disadvantages. It was generally acknowledged that superheated steam had materially less effect on the economy of high than of low speed engines; in fact, Cotterill went so far as to state that the initial condensation in a cylinder varied inversely as the square root of the speed of the engine, which showed how important was the bearing of speed on the advisability of superheating. Mr. Geipel thought tests given by Mr. Patchell went to prove this, for although, unfortunately, in none of the tables did the speed of the engine appear, yet from the description it seemed that they were, with one exception, slow-speed engines, that exception being the test made by himself using the Willans engines, which showed a much less saving. With slow-running engines, especially those which have Corliss or other automatic cut-off gear, the economy due to superheating was by no means overstated by the author. Superheating had, broadly speaking, less beneficial effect in multiple expansion engines than in engines where the whole of the expansion took place in one cylinder—at any rate where the multiple expansion reduces, as it ought to do, the range of temperature. Another point was the increase in the loss by radiation and conduction in the steam-pipes. The speaker had pointed out in the discussion on Mr. Burstall's recent paper on the electric lighting of Edinburgh, that with saturated steam at 150lb. of pressure this loss was as much as half a ton of coal per annum for every square foot of pipe uncovered which is in use during the whole year; or, if lagged, one-third of this amount. Thus for a pipe surface of 1,000 square feet, which was certainly not much for a central station, the loss would amount to, say, 250 tons of coal per annum. Now, if the steam were superheated to such an extent as that mentioned by some of the speakers, this loss would be nearly double. He (Mr. Geipel) would be interested to know if Prof. Unwin, in estimating the saving of coal by superheating at 15 to 20 per cent., included any deduction for this important source of loss. The speaker quite agreed with all Prof. Unwin had said as to the McPhail and Simpson superheater, and that the plan of first superheating the steam, and then taking away the superheat by again passing it through the boiler, was but a makeshift arrangement. Mr. Patchell referred to the great increase in the capacity of his own boiler since adopting this superheater, but before its adoption, on his own showing, the boiler was doing far less than its rated capacity, and he thought that the better boiler efficiency was at least partly attributable to the use of the thicker fire.

ST. PANCRAS VESTRY.

The following is a report of Mr. Albert E. Pycraft, chief clerk of the electricity and public lighting department, on the working of the Regent's Park station installation for the year ending December 31, 1895, together with an abstract of the accounts:

Of the total amount of loans received—viz., £99,700—the sum of £5,616. 1s. 8d has been repaid A further loan of £10,000 has been applied for, but is not yet received. The total capital expenditure on account of the Regent's Park station amounts to £113,889. 2s. 1d., being an increase on last year's account of £4,522. 18s. 4d, which is mainly for extensions of mains, services to consumers' premises, meters, and switches, and an application for a loan for this amount is required to adjust the account. In accordance with the resolution of the Vestry of April 17, 1895, the item £554 4s. 7d. for preliminary expenses appearing in last year's accounts has been written off and charged to the net revenue account. The total revenue for the year amounts to £18,921 17s. 5d., which is a net increase over last year of £1,990. 0s. 10d., but inasmuch as the charge for public lighting for the year shows a reduction of £857. 7s. 4d., the actual increase from private consumers amounts to £2,847. 8s. 2d., or nearly 23 per cent. increase. The total generation expenses amount to £6,737. 14s. 5d., an increase over last year of £561. 4s. 6d., the larger portion of which is for coal. The distribution expenses show an increase of £1,623. 13s. 11d., the large increase under this head being chiefly attributable to the necessity of replacing the whole of the insulators and bearers in the manholes, as a consequence of the explosions in culverts that occurred early in the year. Nearly £600 has been paid to contractors for this work, besides a sum of £300 for extra staff employed in cleaning the incrustation off the old insulators, and other work during the time the new insulators were being put in—a precaution which was absolutely essential owing to the nature of the incrustation and the liability of further explosions should any accumulation of gas be present in the manholes. After providing for the whole of the foregoing expenses a profit of £6,575. 15s. 4d. on the year's trading has been made (equivalent to nearly 6 per cent. on the capital expenditure) to meet the repayments and interest on loans, etc., which absorb £5,640. 10s. 9d., leaving a net profit on the year's working of £935. 4s. 7d. This sum added to the balance on last year's accounts of £1,768. 6s. 7d., less the sum of £554. 4s. 7d., written off for preliminary expenses, leaves a net balance to be carried forward of £2,149. 6s. 7d. The following table shows the yearly progress since the commencement of the electricity undertaking:

Year ending Dec.	No. of consumers.	Current sold to private consumers. 3d. per unit. £ s. d.	Current sold to private consumers. 6d. per unit. £ s. d.	Lamps, etc., applied for. Incandescent. 16 c.p.	Arc.	Motors.
1892	172	—	8,167 7 8	9,990	82	11
1893	238	384 11 6	9,161 6 0	12,851	110	19
1894	349	1,236 13 9	10,819 15 9	15,532	129	22
1895	447	2,142 9 6	12,682 6 0	19,195	139	37

REVENUE ACCOUNT, DEC. 31, 1895.

Dr.				£ s. d.
Generation of Electricity.				
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on works	£3,357	10	3	
Oil, waste, water, and engine-room stores	363	15	7	
Wages at generating station	1,730	0	4	
Sundry petty expenses	101	3	9	
Repairs and maintenance as follows: buildings, £98 10s. 8d.; engines, boilers, etc., £847. 2s. 8d.; dynamos, exciters, accumulators, etc., £139. 16s. 11d.; other machinery, instruments, and tools, £107. 4s.—£1,192. 14s. 3d.; less received for old material, £7. 9s. 9d.	1,185	4	6	
				6,737 14 5
Distribution of Electricity.				
Wages and other remuneration to linesmen, fitters, labourers	557	18	6	
Repairs, maintenance, and renewals of mains of all classes, including materials and labour	2,250	12	3	
Repairs, maintenance, and renewals of meters, switches, fuses, and other apparatus on consumers' premises	87	18	0	
Gas, water, etc., at sub-stations	3	3	5	
				2,899 12 2
Public Lamps.				
Carbons	176	0	8	
Attending	278	16	1	
Repairs	132	4	11	
				587 1 8
Licenses for mains laid on Crown property, etc.				14 8 0
Rates and taxes				391 4 9

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Management Expenses.						
Engineer's department and clerical staff salaries		971	17	8		
Stationery and printing		177	9	7		
General establishment charges		138	7	3		
					1,287	14	6
To law expenses					87	13	6
Special Charges.						
Insurances, etc.		142	15	9		
Expenses fixing meters, etc., on consumers' premises		95	18	4		
Expenses obtaining loans		30	9	6		
Fee for testing meter		0	15	0		
Compensation claims paid for injuries *re* explosions		70	14	6		
					340	13	1
Total expenditure					12 346	2	1
Balance carried to net revenue account					6,575	15	4
					£18,921	17	5

Cr.	£	s.	d.
Sale of current per meter at 6d. per B. T. U., £12,682. 6s.; ditto at 3d., £2,142. 9s. 6d.	14,824	15	6
Public lighting	3,568	13	9
Rental of meters and other apparatus on consumers' premises	463	7	1
Work done on consumers' premises	63	16	1
Sale of lectures and reports	1	5	0
	£18,921	17	5

General Balance-Sheet, Dec. 31, 1895.

Liabilities.	£	s.	d.
Capital account—amount received	116,149	7	9
Sundry creditors	2,617	15	0
Interest accrued on loans	1,358	19	9
Net revenue account	2,149	6	7
	£122,275	9	1

Assets.	£	s.	d.
Capital account—amount expended for works	113,889	2	1
Stores on hand at December 31, 1895—coal, £87. 10s.; oils, waste, etc., £80. 11s. 10d.; carbons, £4. 12s.; general, £1,286. 10s. 6d.; less reduced value charged to net revenue account, £45. 9s.—£1,241. 1s. 6d.	1,413	15	4
Sundry debtors for current supplied to December 31, 1895, £7,057. 14s. 3d.; less consumers' deposits, £114	6,943	14	3
Cash in hand	28	17	5
	£122,275	9	1

Statement of Electricity Generated, Sold, etc., during the Year 1895.

Quantity generated in B.T. units		1,063,322
Quantity sold { Public lamps	171,297	849,987
Quantity sold { Private consumers	678,690	
Quantity used on works		54,807
Total quantity accounted for		904,794
Quantity not accounted for		158,528

The number of public lamps is 97, and the total maximum supply demanded was 11,240 amperes low tension and 80 amperes high tension.

LEGAL INTELLIGENCE.

ELECTRIC CONSTRUCTION CORPORATION v. SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

The first portion of the hearing of this action, before Mr. Justice Romer, in the Chancery Division of the High Court of Justice, was given in our last week's issue. It was resumed on Friday last, when the evidence for the defence having been closed, Mr. Eve, Q.C., decided not to call rebutting evidence.

Sir Frank Lockwood, Q.C., said the two men, Ebbsmith and Wain, were admittedly coupled together for the purpose of defrauding the South Staffordshire Company, and that being so the whole thing must be looked at with suspicion. It seemed to him a most extraordinary thing that any company could have been found to have accepted a contract such as this one.

Mr. Justice Romer said he should like to ask what Mr. Wain's object could have been in entering into a contract which he must have known would mean bankruptcy to the company.

Sir Frank Lockwood pointed out that at this time—1891 and 1892—Mr. Wain was absolutely at the mercy of Mr. Ebbsmith.

Mr. Justice Romer said he should doubt whether Mr. Wain was so absolutely at the mercy of Mr. Ebbsmith as to do an injury to a company out of which he was to get no benefit for himself.

Sir F. Lockwood said that in this particular case they had conduct that was absolutely inexplicable otherwise than by accepting the explanations he gave. What straightforward, honest object could there have been in concealing from the company what the actual contract was, and in packing the meeting with bogus shares for the purpose of carrying resolutions which should enable them to carry out this contract. In conclusion, he submitted they had here a contract impossible of performance. One was bound to ask oneself how it was those responsible so ill advised the company, whose destinies they should have protected. The answer was that they had not the interests of this company at heart, that they were in the hands of a man who was willing to betray, and had betrayed, the company, and his co-negotiator was his criminal associate. That being so, had they far to go to answer the question which should be asked in this case—viz., would it have been possible for such a contract to have been entered into by the South Staffordshire Company unless that company had been betrayed? The answer to this was, no; but for this betrayal the contract could not have existed.

Mr. Eve, in reply, said the real point, and practically the only one, was that the contract was brought about by a claim of fraud, and was so tainted with fraud that it could not stand. He submitted that the evidence did not support any such contention, for up to the end of 1893 there was no suspicion that the men with whom the company were dealing were notperfectly honest, and they were at the very head of their profession, and it was not until just before the trial of these men in this year that the details of the frauds were discovered. It was said that the terms of the purchase were onerous, but even if it would have been better to obtain new engines than to have electric traction, that was a long way from fraud. Mr. Eve pointed out that the defendant company had obtained powers to provide electricity, and having that power they set to work to find a company to supply the motive power, and when the plaintiff company entered into the contract they knew the company could not purchase for cash, and it was under those circumstances that the contract was made both a working and a financial one. He submitted that, taking everything into consideration, it was not a case in which they would impute fraud. If that was disposed of, then the question whether it was an onerous contract was not before the Court. He submitted that the charges of fraud had not been proved. The onus of proof rested upon the defendants in this case. He asked, therefore, for a declaration that the contract was binding on the defendant company, that an account be directed on that footing, and that the counterclaim be dismissed with costs.

His **Lordship** reserved judgment.

COMPANIES' MEETINGS AND REPORTS.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The report of this Company for the half-year ending December 31 states that the total earnings amounted to £80 315, as against £82,815, showing a decrease of £2,500 compared with the corresponding period of 1894. The working expenses were £38,122, as against £36,404, an increase of £1,718. Including £5,803 brought forward, and the dividend received upon the shares held in the "Platino" Company, the balance to the credit of the revenue account is £52,614, from which has been deducted £11,148 for debenture interest and £7,952 for the debenture redemption fund, leaving £33,514, of which £3,000 had been placed to the reserve fund. The directors recommend the payment of 5s. 3d. per share, free of income tax, on the ordinary shares, making, with the dividend paid in November, £3 per cent. for the year, the same as paid for 1894, leaving a balance of £4,953 to be carried forward. In the case of shares which have been divided into "preferred" and "deferred," the 5s. 3d. per share now recommended will be payable—3s. 9d. to the "preferred" shareholders, making up the full dividend of £5 per cent. on these shares for 1895, and 1s. 6d. per share to the "deferred" shareholders. It is stated that there is no change in the position of affairs between the Government of Brazil and the Company as to the purchase of the cables. The shareholders' meeting will take place on May 14.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

The directors' report of this Company for the half-year ending December 31 states that the revenue amounted to £106,168, and the working expenses to £21,623. After providing £3,200 for debenture interest and sinking fund, and £1,706 for income tax, there remains a balance of £79,639, to which is added £4,410 brought forward, making a total of £84,049. First and second interim dividends, amounting to £39,000, have been paid, and £30,000 transferred to the reserve fund, leaving £15,049 to be carried to the next account. The receipts include £1,500 dividend to June 30 last on the Company's shares in the African Direct Telegraph Company, Limited. The various sections of the lines are in good working order. The shareholders' meeting takes place on the 13th inst.

SUBMARINE CABLES TRUST.

The annual meeting of certificate-holders was held last week at Winchester House, E.C., the Marquis of Tweeddale presiding.

After referring with regret to the absence of Sir John Pender, who had occupied the chair at every previous meeting, the **Chairman** proposed the adoption of the report, remarking that on the whole the year had been a prosperous one. The revenue had

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been £22,313, or an increase over that of the previous year of £849. This was owing to the larger dividend which had been received from their investment in the Anglo-American Telegraph Company. The total expenses for the year had been £1,099, or £95 less than in the previous year. Their revenue had enabled them to pay the equivalent of two coupons of £3 each and clear off an additional 5s. of the remaining portion of the overdue coupon, still leaving a balance of £1 in arrear, which there was every reason to anticipate would soon be extinguished.

Mr. J. Denison Pender seconded the adoption of the report, and it was carried unanimously.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Prague (Austria).—Tenders are wanted by June 1 for an electric lighting central station for the city of Prague. Application should be made to the Stadtrath, Prague.

Penaranda de Bracamonte.—Tenders for electric lighting of the town for a period of 15 years may be sent to the authorities at the Casa Consistoria, Peneranda de Bracamonte, Spain, by May 28.

Bruges.—Tenders are wanted by May 13 for the supply and erection of an electric water-level indicator for the River Lys. Particulars from Le Gouvernement Provincial, Bruges, Belgium.

Chapelle-lez-Herlaimont.—Tenders are wanted by May 15 for erecting three lightning conductors on the Hôtel Communal. Address, M. le Bourgmestre, Chappelle lez-Herlaimont, Belgium

Spezia (Italy).—Tenders are wanted by May 11 by the Torpedo and Electric Department at the Spezia Arsenal and Dockyard for the supply of a quantity of copper and brass in wire sheets, and nails, etc.

South African Republic (Transvaal).—The Consul-General of the South African Republic at Amsterdam will receive tenders up to May 15 for the supply of 10,000 insulators and supports for the telegraphs of the republic.

Paris.—Tenders will be received by the Prefect of the Seine at the Paris Tribunal de Commerce on May 23 for the installation and working for 10 years of the electric light at the Hospice de Brévannes. The estimate is about £5,533, and the maximum annual payment 27,000f. (about £1,080).

Bray (Ireland).—The Town Council want tenders by May 17 for (1) a steam alternator, 75 kilowatts; (2) a Lancashire boiler, 200 h.p.; (3) economiser and feed-pump; (4) a vertical high-speed engine. Specifications, etc., can be obtained from Mr. P. MacDonnell, town clerk's office, Town Hall, Bray, on deposit of two guineas.

Portsmouth.—The Guardians of the Portsea Island Union invite tenders for wiring part of the main building of the workhouse for lighting by electricity. Specifications and all other particulars can be obtained from the Superintendent, Portsmouth Corporation Electricity Supply, Gunwharf-road. Tenders must be sent to the workhouse before 4 p.m on 13th inst.

Bucharest.—The Administration of the Roumanian Posts and Telegraphs at Bucharest want tenders by May 15 for the supply of about 21½ tons of bronze and copper wire and a quantity of fastenings. Tenders are wanted by the Municipal Administration of Bucharest by June 24 for a concession for lighting the city for a period of five years. A security of 15,000 lei (about £600) will be required.

Oldham.—Tenders are wanted by May 12 for an engine and dynamo of 360 h.p. from makers only who have previously constructed dynamos of that size. Particulars of Mr. A. Andrew, Gas and Water Offices, Oldham. The Electric Light Committee also want tenders for one Lancashire steam boiler 28ft. long and 7½ft. diameter, to work at a pressure of 125lb. A copy of the specification may be obtained on application to Mr. Andrew, to whom tenders are to be sent by May 12.

London, E.C.—The Great Eastern Railway require tenders for telegraph materials, etc. Forms of tender may be had on application to the Secretary's Office, Liverpool-street Terminus, E C. The patterns may be seen at the Company's Stores, Stratford, between 10 a m and 4 p.m. up till the 13th inst. The company's patterns cannot be sent away for inspection. Tenders, endorsed "Tender for Stores," to be forwarded by post to Mr T. D. Genlloud, secretary, Liverpool-street Terminus London, E.C., so as to be received by 10 a.m on 14th inst.

Wakefield.—Tenders are invited for the construction and erection of Contract No. 2, electric lighting buildings, etc., at Calder Vale, Wakefield, for the Council Plans and specification may be seen and bill of quantities and form of tender obtained (on payment of £1. 1s., to be returned on receipt of bona fide tender) at the office of Mr. R. Porter, city surveyor, Town Hall, Wakefield. Tenders for the whole of the works, or for the works comprised in each separate trade, addressed to the Town Clerk, Town Hall, Wakefield, should be delivered by 13th inst, endorsed "Tender for Contract No. 2."

Hammersmith (London).—The Vestry want tenders for the following: (*a*) the supplying and laying of high pressure and low-pressure cables and pipes; (*b*) the supply and erection of arc lamps and lamp-posts; (*c*) the supply and erection of transformers and sub-station equipment; (*d*) the supply and erection of a five-ton overhead travelling crane. Specifications, general condition, and form of tender can be obtained at the office of Mr. A. H. Preece, 39, Victoria-street, Westminster. Applications for any one or all of the above sections must be accompanied by a cheque for £2. 2s. which will be refunded on receipt of a bona fide tender. Sealed tenders, endorsed "Cables," "Arc Lamps," "Transformers," or "Crane," must be delivered at the offices of the Vestry, 57, Fulham Palace-road, Hammersmith, by noon on 27th inst. Mr. W. P. Cockburn, vestry clerk.

Coventry.—The Electric Lighting Committee require tenders for the supply and erection of the following plant: (Section A) boiler-house plant—boilers and fittings, mechanical stokers and economiser, feed pump, etc.; (Section B) engine-house plant—steam-engine, alternator, oil filter, fittings, etc., steam, exhaust, feed blow-off, sundry pipes, valves, etc. Tenderers are at liberty to tender for either section, but not for part of a section. The ground plan of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. Lewis Beard, town clerk, St. Mary's Hall, Coventry, and delivered by May 12.

RESULTS OF TENDERS.

London.—For the construction of a section of the Central London Railway the tender of W. Scott and Co., Newcastle-on-Tyne, has been accepted.

Leeds.—At a meeting of the Tramways Sub-Committee of the Leeds Corporation tenders have been opened for the supply of about 1,000 tons of rails which are required for the relaying of the tramway lines along portions of the proposed electrical tramway route from Roundhay to Kirkstall. There were a dozen tenders sent in, the prices ranging from £6. 9s. per ton down to £5. 15s. The committee decided to recommend the acceptance of the tender of Mr. Leonard Cooper, whose quotation for the rails was £5. 15s. per ton. There will be a small allowance in addition for fastenings.

Hull. — The Electric Light Committee have received the following tenders for the supply of coal from the 1st inst. to December 31, 1896: A. Bannister and Co., 11s. 4d. (accepted); Denaby Main Colliery Company, Limited, 11s. 1d.; Hickleton Main Colliery Company, Limited, Thurnscoe, near Rotherham, 11s. 2d.; Hoyland Silkstone Coal and Coke Company, Limited, near Barnsley, 11s. 8d.; G. D. Strachan, 11s. 6d., 11s. 8d., and 11s. 8d.; M. Strachan and Son, 11s. 4d., 11s. 2d.; Sylvester and Co., Eastcheap-buildings, London, E.C., 11s. 2d.; W. Thorp, 11s. 7d. Rest of Hull.

Bradford.—The following tenders were accepted for the erection of a building required for the new electricity station at the junction of Valley-road and Lionel-street in the borough, for the Bradford Corporation. Mr. Thomas Barker, A M.I.C.E., 5, Bond-street, Bradford, architect:

J. Moulson and Sons, Bower-street, masons	£7,350
H. Thirkhill, Ripley-street, joiner	810
Hill and Nelson, Edmund-street, slaters	810
Roberts and Co., Limited, Dudley-hill, ironfounders	1,188
R. Townsend, Croft-street, plumber and glazier	333
T. Bolton, Tudor-street, plasterer and concretor	395
G. J. Walton, Horton-road, painter	117
Wood Block Flooring Company, London, flooring	55
Coalbrookdale Company, Salop, gates and railings	124
Rest of Bradford.	

BUSINESS NOTES.

Wakefield.—The electric light has been inaugurated at Belle Vue.

Merthyr.—The provisional order for electric lighting has been granted.

Direct Spanish Telegraph Company.—For the month of April the receipts were £2,422.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,583.

Great Northern Telegraph Company.—For the month of April the receipts were £23,200.

Manchester.—The Town Council have decided to apply for power to borrow £100,000 for extending the electric light.

Bangor (N. Wales).—The Board of Trade have refused the license applied for by the Town Council for lighting the city electrically.

Eastern Telegraph Company.—The receipts for the month of April were £72,824, as against £67,046 for the corresponding period of 1895.

Cheltenham.—A scheme is on foot to run a light railway to Cheltenham, taking in the Cleeve Common Golf Links, and then on to Winchcombe.

Eastern Extension Telegraph Company.—For the month of April the receipts show an increase of £9,356 as compared with the corresponding period of 1895.

Walsall.—The General Purposes Committee will submit for formal adoption at the next Town Council a resolution for acquiring the tramway lines within the borough.

West India and Panama Telegraph Company.—For the two weeks ended April 30 the receipts were £2,776, as against £2,656 for the corresponding period of 1895.

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Paddington.—At the last meeting of the Vestry a proposal to obtain estimates for lighting the workhouse chapel by electricity for three months was adjourned for six weeks.

West Hartlepool.—Another satisfactory trial of the cars on the electric tramways took place the other day, exciting considerable public interest. The service will shortly commence.

Lydd.—An electrical plant has been laid down near the camp for the purpose of working the search light. This will be used for heavy gun firing practice at various objects at night-time.

North Staffordshire Tramways Company.—The annual supper of the employés of this Company took place at Shelton last Wednesday evening. Mr. W. J. Carruthers Wain, chairman of the directors, presided.

Chichester.—A company has been registered by Messrs. C. Doubble, 14, Serjeants'-inn, E.C., with a capital of £12,000 in £5 shares in order to construct and work a tramway between the city of Chichester and Selsey.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending May 3 amounted to £1,145, as compared with £1,148 in the corresponding week of the previous year, being a decrease of £3.

Battersea (London).—The Board of Trade have decided to grant a provisional order to the Battersea Vestry authorising them to supply electricity within the area of their jurisdiction. The order authorises the expenditure of £50,000.

Blackpool.—The *Blackpool Times* says that the electricity works will probably show a profit of nearly £300 on the year's working, and congratulates Mr. Hesketh on the fact that he has been able to "turn the corner" before he leaves.

Douglas (Isle of Man).—The laying of the lines of the Southern Electric Tramways is practically finished. The electrical machinery is on the ground and the boilers are being placed in position, with a view to opening the lines for traffic in June.

Islington (London).—To-day (Friday) the Vestry have to consider a report of committee recommending the laying of extra mains, the extension of the station, and the provision of extra plant. The total expenditure recommended is over £37,000.

Barrow-in-Furness.—During the week the borough has been visited by Mr. Manville, M.I.E.E., of the firm of Kincaid, Waller, and Manville, electrical engineers, who have been asked to inspect and report on the question of a public electric installation for Barrow.

Lynn.—The Provisional Orders No. 1 Bill, which confirms certain orders made by the Board of Trade under the Electric Lighting Acts of 1882 and 1888, relating, among other places, to Lynn, has passed the Committee on Unopposed Bills in the House of Commons.

Brighton.—The Bill to extend the time for the completion of the Brighton and Rottingdean Seashore Electric Tramroad to July, 1898, met with no opposition before the Examiner on Standing Orders in the House of Lords, and it was ordered to be reported for second reading.

Telescriptor Syndicate, Limited.—This Company has been registered, with a capital of £40,000 in £1 shares, to enter into an agreement with B. Hoffmann for the acquisition of certain patents relating to improvements in telegraphic apparatus and typewriting machines.

Grimsby.—The Electric Lighting Committee have after much discussion agreed to recommend to the Council that, as soon as the provisional order lapses, they apply for a renewal and also that the sub-committee be empowered to visit other towns for information in the meantime. The Town Council have adopted this report.

New Companies and Electric Work.—The following new companies take power to make electric tramways, or undertake other electric or telegraphic work—viz., the Barberton Consolidated Gold Fields, Limited; the Rhodesia-Sebakwé Development Syndicate, Limited; and the Barrow Bay (Canada) Estate and Manufacturing Company, Limited.

City and South London Railway.—The returns for the week ended May 3 were £878, compared with £864 for the corresponding period of last year, being an increase of £14. The total receipts for the half-year terminating as above were £17 027, compared with £16,983 in the same period of the preceding year, being an increase of £44.

Hammersmith.—The Electric Lighting Committee of the Vestry have reported that the plans for the new electric lighting station had been prepared, and the Vestry passed them. Upon the recommendation of the committee it was also agreed to purchase three rectifiers from Messrs. Ferranti at the price set out in their tender, £1,044. 15s.

Country-House Lighting.—We are informed that Captain Wingfield Stratford, of Woolton, has placed with Messrs. Drake and Gorham, 66, Victoria-street, Westminster, the contract for the electric lighting of his country house. There will be a petroleum engine, latest pattern dynamo, and 53 D.P. cells.

St. Pancras.—The Electricity Committee of the Vestry have reported that a profit of £6,575. 15s. 4d. has been made on the year's trading. This is equivalent to a return of 6 per cent. on the capital outlay. The Vestry have sanctioned the expenditure of £450 in putting down another boiler at the destructor.

Middlesbrough.—At a meeting of the Electric Lighting Committee a report from Mr. Hammond, engineer, was read in favour of electric lighting for the town. He recommended an installation at a cost of £21,000. After the matter had been fully discussed, the recommendation was negatived, two voting for it and eight against.

Peterborough.—At a meeting of the Town Council the following resolution was defeated, after much heated discussion: "That in view of the information acquired by the Council since January 28, 1896, it is undesirable to proceed at present with the application for leave to borrow £20,000 for electric lighting supply, and that such application be therefore withdrawn."

Canterbury.—The Town Council have decided to adopt the electric light, and have appointed an engineer to prepare plans for the necessary works. They have also agreed to apply to the Local Government Board for authority to raise a loan of £20,000 for the purpose. It is expected that the cathedral will be one of the first buildings in the city to be illuminated by electricity.

Bury St. Edmunds.—At the meeting of the Guardians a letter was received from the Eastern Counties' manager associated with the National Telephone Company stating it was contemplated to establish a telephonic exchange at Bury St. Edmunds, and asking whether the Thingoe Board would subscribe and have communication established with the workhouse. The application was declined.

Appointment Vacant.—The Governors of the East London Technical College, in connection with the People's Palace, are about to appoint a professor of physics for classes in connection with laboratory work in electricity, sound, heat, and light. The salary is £150 per annum, with a capitation fee, and attendance is required on two afternoons and four evenings a week during the session.

Alderley Edge (Cheshire).—A company has been registered, with a capital of £30,000 in £1 shares, to enter into an agreement with the Alderley Edge Urban District Council for the transfer of the provisional order granted by the Board of Trade for the generation and supply of electricity within the said district, and to carry on the general business of electrical engineers and suppliers of electricity.

Liverpool Meter Company, Limited.—This is the title of a new company registered by T. T. Hull, 22, Chancery-lane, W.C., with a capital of £30,000 in £1 shares, to carry into effect an agreement made between the Wirral Engineering Company, Limited, W. Alexander and W. E. Thompson, P. L. Birley, and the Company; and to carry on the businesses of gas engineers, electricians, and general engineers, etc.

International Improved Electric Company, Limited.—This Company has been registered with a capital of £75,000, divided into 75,000 shares of £1 each, to carry into effect an agreement made between Ferdinand Fanta and S. A. Bartlett, on behalf of this Company, to acquire the benefit of inventions for improved electric incandescent lamps, and the letters patent in respect to them. The registered office is 1, Arundel-street, Strand.

Taylor and Field.—Mr. J. H. Field, who in recent years has had charge of the equipment of several important installations in Scotland, has now entered into partnership with Mr. F. H. Taylor, late of 17, Ironmonger-lane. The new firm have their offices in 14, Victoria-street, Westminster, and will undertake all classes of wiring work and the laying down of isolated plant for the generation of electricity for private and manufacturing purposes.

Aberdeen.—The Town Council have decided to proceed with an extension of the electric lighting works at an estimated cost of £4,500, and that two new boilers, with water-heater and feed-pumps, be obtained at an outlay of £3,000. It was also agreed that the main should be extended from Union-street round Golden-square at an expenditure of £300, and the main in George-street, for a distance of 40 yards beyond the Northern Hall, at an expense of £280.

Central London Railway.—At the Guildhall, Westminster, last Saturday, before Mr. Troutbeck, the deputy high bailiff of Westminster, and a jury, the case of the Rev. C. G. Anderson *v.* the Central London Railway Company came on for hearing. It was a claim against the company for the sum of £8,464 as compensation for freehold premises, 15, Argyll-street, Oxford-street, required by the company for the construction of the Oxford-circus railway station. The jury assessed the compensation at £8,085.

Belper.—At a special meeting of the Urban District Council Mr. Smedley said he was not now prepared to go on with his proposal that they should apply to the Board of Trade for a license to adopt the electric light for the town, as the Council did not see their way to treat with the gas company. He was now of opinion that they had better get the water question settled, and he should never agree to the electric light being adopted without the other proposal going along with it. The motion to apply was therefore withdrawn.

Newington (London).—The Board of Trade having refused to sanction an application of the Vestry for a provisional order to supply electricity in the parish, it was believed that the refusal was due to an idea that the order, if granted, would not be carried into effect, and therefore Mr. Smithers moved a resolution stating that the order would be carried out if obtained. On a division this was passed by only 23 to 21, but the majority being so narrow it was decided not to send a deputation to the Board of Trade on the subject.

Fife.—At a meeting of the Road Board it was recommended that they construct a telephone system to and from the following places: Cupar, Dunfermline, Dysart, Lochgelly, Springfield, Ladybank, Markinch, Thornton, Leven, Kirkcaldy, Burntisland, Aberdour, St. Andrews, Cowdenbeath, Newburgh, and Newport. The total distance would be 81 miles, and the cost per mile was estimated at £12 11s. 10d. It was resolved to send a memorandum to other county councils in Scotland detailing what had been done

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in Fifeshire, and urging them to join in pressing the Government on the subject.

Chelmsford.—At a meeting of the Town Council the Lighting Committee reported that they had considered the specifications of the lighting plant, etc., from Messrs. Crompton and Co, in reference to the purchase of the electric lighting undertaking, and also a letter received from the company, dated March 23, in which they stated they were prepared to sell the undertaking, including the provisional order, works, machinery, mains, and the business as a going concern for £34,328. The committee recommended that authority be given them to consult an expert before coming to any conclusion. The Council adopted the recommendation.

Bolton.—The Joint Committee (the Streets and Electric Lighting Committees) have considered the memorandum of the deputation which has been to Bristol and Walsall to inspect the electric trams there, and have resolved that it is desirable electrical traction should be adopted for the working by the Corporation of the tramways, that in the opinion of the sub-committee the overhead system should be adopted, and that the lessee of the tramways be invited to confer with this sub-committee as to commencing the adoption of the system. The Council have adopted this report, and the system will be tried on the Daubhill section of the lines.

Electrolytic Gold Winning in West Australia.—At the (statutory) general meeting of the Sugarloaf 25-Mile Cement Leases Company, held in the City, Mr. H. W. Lowe (the chairman of the company), in reply to a shareholder said the machinery ordered for the mine was not on the ordinary process, but was a process of electrolysis with the separation of the gold by means of electricity. It was cheaper than any other machinery, and was well worth a trial. If it answered well they could enlarge their plant later on, and if it did not answer they would in the meantime have derived the benefit of other experiments and would be ready to adopt some other process. The amount of outlay was so small that it would not be a very serious matter either to renew or to change their plant.

Derby.—The Electric Lighting Committee reported at the meeting of the Town Council that two new transformers have been ordered from Messrs. Siemens Bros. at a cost of £268. A 1½-h p. motor has been ordered for coal hauling at a cost of £32. Messrs. Siemens Bros. have presented to the committee 200 yards of arc light cable. Three hundred and fifty yards of high-tension cable have been purchased from the British Insulated Wire Company at a cost of £49. 14s. 4d. The Local Government Board have declined to sanction the borrowing of the sum of £419, being the costs incurred in obtaining the electric lighting provisional order. The Local Government Board have held an enquiry as to the borrowing of moneys upon the electric lighting account. Their decision has not yet been received. The tender of the British Insulated Wire Company for cables, junction-boxes, and jointing, amounting to £2 185, has been accepted.

Dover.—At the meeting of the Town Council, Councillor G. F. Fry said he wished to give notice of motion for the next Council meeting He noticed in the papers that the tramway question was coming to the front, therefore he hoped that the Town Council would, before entering on a large expenditure that this undertaking would involve, take steps to obtain the best information. His motion would be to the effect that the Mayor, the deputy mayor, the surveyor, and some gentleman representing the other side of the House—perhaps Mr. Bradley—should go to Rouen, where 25 miles of tramways had been laid down on the overhead system, which seemed to be the best system in existence. He thought that if that were done, the gentlemen would be able to advise the Council as to the propriety of going on with the tramways, and as to what character they should be. The Mayor asked if the motion could not be so worded as to enable them to go to any other place, and this was agreed to. The Board of Trade have approved the proposed tramway scheme.

Chelsea Electricity Supply Company.—The directors of the Chelsea Electricity Supply Company, Limited, have announced the issue, at a premium of £2 per share, of 12,000 ordinary £5 shares, ranking for dividend at the rate of 2½ per cent. per annum until December 31 next from the due dates of the respective instalments, exclusive of the premium, after which they will rank with the existing shares. The prospectus states that the Company supplies electricity on a continuous system in the parish of Chelsea, and last year had a gross revenue £17,165, as against £6,080 in 1890. A dividend of 2½ per cent. was paid on the ordinary shares in 1892, and 5 per cent. in each of the succeeding three years. The authorised share capital is £200 500, divided into 34,000 ordinary and 6,000 6 per cent. preference £5 shares, and 500 founders' £1 shares. The preference and founders' shares have all been issued, and 14,000 of the ordinary shares, the whole being fully paid up. There has also been issued £60,000 4½ per cent. debenture stock. The list of subscriptions opened on Thursday, and closes to-day (Friday).

Kensington.—The Works and Sanitary Committee have had before them the revised regulations made by the Board of Trade for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy which are imposed upon the respective electric lighting companies in this parish, together with reports by the surveyor and lighting engineer thereon. The committee have reported that the regulations themselves do not appear to call for any special action on the part of the Vestry, but it has been pointed out that the Vestry may, subject to the approval of the Board of Trade, make by-laws for further securing the safety of the public. The committee were of opinion that the Vestry might take advantage of this power to ensure that the regulations of the Board of Trade above referred to are duly regarded; and they accordingly recommended that a by-law be made under Section 6 of the Electric Lighting Act, 1882, as follows: "The electric lighting companies having areas of supply in the parish of Kensington shall once at least in every six months furnish to the Vestry a report setting forth the action taken by them for complying with the regulations made by the Board of Trade."

Bray (Ireland).—At the meeting of the Commissioners, a letter was read from Messrs Molloy and Molloy, solicitors, with reference to postponing the consideration of the electric tramway scheme for six months, pointing out that the action of the Commissioners in so doing meant that they could not hear the application of the promoters, as a grand jury, before this time next year. They therefore asked the Commissioners to pass such a resolution as would permit them to avail of the extension of time clauses in the Tramway (Ireland) Act, 1883 and proceed under that Act at the next summer assizes. The Chairman said he was as anxious as any gentleman in the township for the prosperity of Bray. He had given the question of the proposed tramways a great deal of consideration, and he would wish to ask those who were in favour of the scheme was Bray a place that was likely to grow into a large commercial centre, or a place for fashionable people to come and reside? If they permitted the trams to be laid, there would be a block in the traffic in the narrow part of the streets. Captain Patrickson said he was going to propose a motion in favour of the trams, but after what the chairman had said he would not do so. It was ultimately decided not to take any action in the matter, in view of the resolution passed at the last meeting with reference to the subject.

Croydon.—At the meeting of the Corporation the General Purposes Committee reported that they had considered a report from Prof. Kennedy as to the arc lighting, the report stating that the professor, having gone into the question in some detail, finds that it is not possible with such a scheme as he thinks the Council would be well advised to adopt to include arc lighting under the original loan. The additional expenditure necessary for carrying out the scheme as now recommended by the professor will be about £1,500. Prof. Kennedy suggests that if further borrowing powers be obtained, it would be advisable to obtain sufficient to cover the cost of putting up a condensing plant and the pipes connected with it, as well as the permanent chimney The cost of the whole of these works, including the £1,500 as above, would be about £4,700. Upon the suggestion of the Electric Lighting Sub-Committee, who had considered this matter, the committee recommended that the Council should apply to the Local Government Board for sanction to a further loan of £5,000 on account of the foregoing works. The committee further recommended that in view of the extension of the electric light to areas outside that at present proposed to be lighted, and for which a demand had already sprung up, the Council should seek the sanction of the Local Government Board for a further loan of £5,000 on this account.

Exeter.—At the meeting of the Governors of the Devon and Exeter Hospital Colonel Lucas stated that the machinery and apparatus required for the new laundry could also be used for generating electricity. Veale and Co., St. Austell, estimated the cost of installing the light at £896, but contingencies would bring the total up to £1,195 The medical staff were in favour of the electric light. The cost of working would be about £190 a year, or £50 less than the cost of their gas. There would also be a saving in renewing pipes, and in painting and whitewashing to the extent, it was thought, of nearly £200 a year. The committee strongly recommended the adoption of the light, and he moved that £1.000 be obtained to carry out the installation. Mr. Franklin seconded, and the report was adopted by 22 votes to 3. At a meeting of the City Council the Town Clerk read the following communication, dated April 28, from Mr. T. W. L. Pelham, of the Local Government Board: "Exeter Electric Lighting Order, 1891.—With reference to previous correspondence on the subject of the above-mentioned order, I am directed by the Board of Trade to inform you that they have revoked the order, and to transmit to you, for the information of the Corporation of Exeter, the enclosed notice of revocation. I am, at the same time, to refer you to the provisions of Section 68 of the order with reference to the time within which notice requiring the undertakers to sell the undertaking should be served upon them." On the motion of Mr. Wreford, it was resolved that the application be made requiring the undertakers to sell the undertaking as from June 30.

Fulham.—At a meeting of the Electric Lighting Committee, the report drawn up by Mr Medhurst with reference to the electric lighting of the borough and providing a dust destructor was considered. Mr. Drew said that there did not seem any occasion for them to hurry on the matter. Having regard to the fact that they were on the eve of an election, and that it was quite possible that some of them might not return to the Vestry, he thought that it would be the best for that business to stand over until the new committee had been formed. It might perhaps go before the Lighting Committee. However, he moved that the matter be allowed to stand over until after the new Vestry had been elected. Mr. R E. Cranfield seconded the motion, and said at the same time he hoped that the matter would certainly not go before the Lighting Committee. If the question was going to be referred to them, there would not be a member who would really know anything about it, because they were so irregular in their attendance. He hoped that the matter would be sent to the new committee. Mr. Drew's motion was put by the Chairman to the committee, and declared carried. Mr. C. Thomas attended as a member of the Vestry, and read a report of the working of the electric light in Westminster. That system, he said, if adopted, would save the ratepayers the sum of £7,000. He had no interest in the concern, but simply brought it before the committee for

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their consideration. Mr. F. H. Medhurst said that he did not think that the system adopted at Westminster could be used at Fulham with any success. Ultimately Mr. Thomas's recommendation was referred to the surveyor to consider.

York.—At the quarterly meeting of the City Council it was stated that Prof. Kennedy had attended before the Streets and Buildings Committee, and discussed in detail the report which he had submitted respecting the electric lighting of the city, and the committee resolved that he be requested to prepare a specification for the electric lighting of the city with a view to tenders being obtained for the supply and fixing of the necessary plant. Mr. Lambert moved as an amendment that "the public debt of the city having reached approximately £500,000, owing chiefly to the extravagance of the School Board and the extraordinary cost of the new sewerage scheme, it is undesirable to enter upon any new scheme such as the adoption of an electric lighting system under municipal management, and that the resolution to keep the electric lighting of the city in the hands of the Corporation be rescinded." He said that many towns about the size of York that had adopted electric lighting had lost on the undertaking. Mr. Brown seconded the amendment. Mr. Purnell said many towns had made considerable profit even on the first year's working, and he believed that the electric lighting of the city would pay, and ought to be undertaken by the Corporation rather than by a private company. Alderman Wragge thought it would be most suicidal to pass the amendment when the committee had been instructed by the Council to report and prepare specifications for which the Council would have to pay 100 guineas. Mr. H. V Scott said there were 31 companies lighting towns, and 29 of them were making large profits at the cost of the towns. After further discussion the amendment was defeated by 17 votes to 9, and the report was adopted.

Belfast.—At a meeting of the Law and Improvement Committee the Belfast Street Tramway Company's application for a provisional order was discussed at length. It was elicited during the proceedings that at the present time the tramway company's lines in the city and suburbs cover an extent of 20 miles, and that their gross receipts last year totalled £103,000, 8 per cent. on which would amount to £8,200, whereas the Corporation are receiving £4,000 from the company. Ultimately it was moved that the tramway company be informed that whilst approving of the order in Council as amended making it permissive, the Corporation would not give their consent to the doubling of the lines under the order unless the company would pay a yearly rent of £200 per mile for such additional mileage. The resolution was carried, with a few dissentients. At the quarterly meeting of the Corporation, a deputation attended from the Trades Council urging the necessity for early tramway extension at the cost of the Corporation Councillor George Andrews moved the adoption of the report of the Electric Committee, which contained the following: "Your committee have under consideration the probable extension of the electric lighting system and the consequent necessity of providing a suitable site for a station capable of accommodating the plant required, but they are not yet in a position to make any definite recommendations on the subject." Councillor Andrews said the committee had under consideration the erection of a steam generating station, so that they might be in a position to supply electric current to the whole of the city. They hoped to lay a report on the matter before the Council on June 1 next. They had considered the question of site, but there were some little difficulties in the matter that they would like to have settled before they came forward with a report. They would have to ask the Corporation for land, or for money to purchase land. Councillor Jaffé seconded the motion, which was passed.

Cardiff—A new industrial and fine-art exhibition has just been opened, and contains a fine display of electrical and telegraphic machinery and apparatus. The total space taken up by the engineering and electrical section is about two-fifths of the total area covered by the buildings. It consists of the western bay of the main building, which is a space equal to that of the mining and agricultural sections put together, and it also includes a minor annexe, in which are the electric lighting engines. In the centre of the building comes the electric lighting plant, which consists of four pairs of engines all compound and one pair of vertical engines. There are also a large horizontal main engine and two pairs of smaller engines for stand by's and supplementary work. These engines all serve the double purpose of being exhibits and working the electric lighting machinery. There are five dynamos and two exciters driven by a countershaft between the dynamos and the engine; in other words, the engine drives the countershaft and the latter the dynamos. The engines will drive up to 200 arc and 600 incandescent lights, the latter being mostly of 16 c.p. The engines are supplied with steam from two batteries of two multitubular boilers by Babcock and Wilcox. These are calculated to give, if required, 1,000 h.p. In addition to these boilers there is one small battery of boilers put in by Messrs. Hornsby, of Grantham, that is to be used as a kind of stand-by. A steam-pipe from these main boilers supplies first the electric plant, and then steam to a pair of Braithwaite's high-speed engines, which go at a pace of something over 400 revolutions, and drive the main shafting at 180 revolutions per minute. These are calculated to give 200 h.p. if required. At a meeting of the Executive Council on Monday Mr. J. H. Hallett submitted the offer of a gentleman to provide a search-light and run it, on condition that the electric current was provided. The subject was referred to the Machinery Committee.

Bristol.—At a special meeting of the Town Council, Councillor Pearson moved the adoption of the report of the Electrical Committee, and asked the Council to go on with the extension of the station, a work which would ultimately cost £75,000. When the station was complete they would have on the site something like 5,000 h.p., and they could place additional dynamos up to 1,000 h.p., either for motive power or arc lighting in the streets. The public lighting had practically remained the same from the beginning, but the private demand had increased most satisfactorily, until they estimated that the revenue for the year ending September 1896, from private consumption would be nearly £6,500. The committee desired to induce the Council to increase the supply as required, the committee believing that the public demand was far from exhausted. The result of the trading of the last half-year was that, after paying all the expenses of the station, interest, and the sinking fund, a profit had been made of about £1 500, and they proposed to use this to meet the deficiency which was likely to ensue in the present half-year, when, on the account of the long days, there was less demand for the light. The department now cost the city nothing, and the time was gone when any demand would be made. With regard to what they intended to do with the money, they purposed in the building to divide it into three yearly instalments The estimated cost they reckoned at £74,735, and therefore they thought it well to ask for £75,000. When these works were complete, they would, if necessary, be able to supply the whole of the tramway service with motive power without adding another brick to their station or another tile to their roof. They had said nothing in the report as to the arc lighting, because the committee were not responsible for that; but if the Council were to ask for an extension of the street-lighting they would extend it in the direction indicated, and bring up an estimate of the expenditure and the revenue. He hoped that the committee would receive the support of the Council, because he thought the public-spirited way in which the citizens had taken up the light justified the attempt they were making to increase it Councillor Tryon seconded the resolution, which was carried, after some discussion. The further extension of the system in the streets was referred to the committee.

Lighting Picture Galleries.—In connection with Sir Noel Paton's great picture "De Profundis," which is now being exhibited at Messrs. Grindley and Palmer's Galleries, Church-street, Liverpool, it may be mentioned that their premises have been completely renovated. One of the most interesting features of the alterations is the new electric light installation, which has been carried out by Mr. Charles Rettie, of 18, Geraint-street, Liverpool. The old installation, which only consisted of a very few lights, has been replaced by an entirely new plant, consisting of 119 lights. This installation is of rather more than usual interest, as it marks another departure in the use of the electric light. Up to the present time picture dealers and others have been rather prejudiced against the use of the electric light. They admitted its superiority over all other illuminants as far as cleanliness and preservation were concerned, but on account of the supposed glare thrown on the pictures (especially on large exhibition pictures) they prohibited its use. That prejudice has apparently quite disappeared, as the present action of Messrs. Grindley and Palmer proves. The installation is carried out on the distributing system, and is thoroughly up to date. It is divided into four main sections, which are divided again into several small sections distinctly separate from each other, the whole being controlled by two D.P. switches 50 amperes and 25 amperes respectively. Too much stress cannot be made on this point, as it is not generally known that the mere fact of turning off the lights does not necessarily stop the current, and unless double-pole switches were inserted in the system so as to completely sever both wires when leaving premises at night, a fire might break out at any moment. This fact is laid down in the Phœnix rules, but is seldom taken notice of, the usual thing being to switch off by a single-pole switch (at the meter) put in by the supply company or corporation. There are also six sectional 25-ampere switches, as well as a small switch to every light or cluster. There are three large switchboards, made of black St. Anne's marble, which contain all the switches and D.P. cut-outs. There are no fittings shown on the walls, except in the workshop, basement, storerooms, and window. All the fittings were made to order, and are specially designed jointly by Messrs. Grindley and Palmer and Mr. Rettie As regards the lighting of the picture, it is all that could be desired, and is a great success. The fitting which is used is very simple and portable, and can be taken down by any of the shop assistants when exhibition is over without any skilled knowledge. Mr. Rettie can claim to be the first to introduce permanently the electric light in Liverpool for exhibiting large pictures, the first being the "Saving of the Colours," by Mr. R. Gibb, R.S.A., which was exhibited by Mr. Dunthorne in his Rembrandt Art Gallery, Castle-street, Liverpool. This is the first large installation carried out under the new Board of Trade rules, and it was subjected to a severe test by a small alternating machine which will test up to 300 volts, and was entirely satisfactory. Most of the wires were one night flooded with water, caused by the bursting of a water-pipe in an adjoining building, and the test showed more than double the requirements of the 1896 rules of the Phœnix Fire Office.

PROVISIONAL PATENTS, 1896.

APRIL 27.

8892. Improvements in and relating to switchboards to be used for telephonic purposes. Charles Shore and Charles Heap, Old Market-chambers, Yorkshire-street, Rochdale.

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8810 **Improvements in dynamo-electric machines.** Joseph Edmondson, Penny Bank-chambers, Halifax.

8815 **Improvements in or connected with electric light switches.** George Davis, 246, Vauxhall Bridge road, London

8819. **Railway pilotman's substitute apparatus for working single line during failure of "tablet" or "electric" staff working.** John Walter Mitcherd Penrhynden draeth Station, Merioneth.

8846. **Improved dynamo-electric machine.** Harold Sandwith, *Invention* Office, Mitre-court, Fleet-street, London

8853. **A new or improved construction or arrangement of generator of electricity.** Henry Arzt, 166 Fleet-street, London. (Complete specification.)

APRIL 28.

8890. **Electricity and water supply for household and other purposes.** Thomas Meacock 18, Burlington-chambers, New-street, Birmingham.

8906. **Improvements in the generation of electricity.** Llewelyn Birchall Atkinson and Frederick Gwilym Treharne, 10 Westbourne-road, Penarth, S. Wales.

8943. **Improvements in the fixing of metal caps to incandescent electric lamp bulbs.** Robert Williams, 18, Homefield-road, High-road, Chiswick.

8948. **Improvements in electrical signalling apparatus.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Gwynne Ernest Painter, United States.) (Complete specification.)

8964. **Improvements in electrical furnaces.** Oliver Imray, 28, Southampton buildings, Chancery-lane, London (Dugald Graham, Canada.)

8973. **Improvements in electrical organs.** Richard Percy Strand, De Blaviere Carritte, and Charles Alfred Stockton 40, Chancery-lane London. (Complete specification.)

8988. **Improvements in or relating to arc lamps.** William Phillips Thompson, 6, Lord street, Liverpool. (Malone Wheless, United States.) (Complete specification.)

8995. **Improvements in or in connection with incandescent electric lamps.** Julius Bartels, 6, Lord-street, Liverpool.

APRIL 29.

8999. **Duplex or multiplex telephony.** Abner Mulholland Rosebrugh, 107, Mutual-street, Toronto, Canada.

9014. **Improvements in electric temperature alarms.** George James Baird, 70. Wellington-street, Glasgow.

9030. **An improved automatic electrical cut-out.** William Walter Channon, 43, Southampton-buildings, Chancery-lane, London.

9043. **Improvements in electric transmitting apparatus for indicating fluctuations in prices on cotton or any other exchanges.** Theodore Sophocles Baltazzi, 6, Lord-street, Liverpool.

9047. **Method of and apparatus for heating by electricity.** Theophilus Davies Farrall, 53, Chancery-lane, London.

9043. **Electrical fog-signalling apparatus.** Herbert Tomlins and Charles Richard Gurr, 53, Chancery-lane, London.

9055. **Improvements in fireproof cements and varnishes for electrical and other purposes.** Illius Augustus Timmis, 2, Great George-street, Westminster.

9060. **Improvements in and connected with telephones for domestic use.** George Lee Anders and Julius Edward Wedekind, 1, Clerkenwell-road, London.

MAY 1.

9171. **Improvements in underground conduits for electric railroad or street railway systems.** Wallace Fairweather, 62, St. Vincent-street, Glasgow. (Munson, Roberts, Alston, Reid, and Reid, ———.) (Complete specification.)

9233. **Improvements in prepayment mechanism for gas, electricity, and other meters** Henry Alfred Willey and Stephen Simpson, 11, Southampton-buildings, Chancery-lane, London.

9257. **Improvements in or relating to electric arc lamps.** Carl Grahner, 31, Southampton buildings, Chancery-lane, London. (Complete specification.)

9258. **Improvements in or relating to combined astatic and dead-beat galvanometers, especially for use on board ship.** Thomas Clark, 31, Southampton-buildings, Chancery-lane, London.

9262. **Improvements in switch apparatus for use in distributing electricity for telephonic, telegraphic, and other purposes.** Robert Pippette, 51, Upper Tulse-hill, Brixton hill, London.

MAY 2.

9266. **Improvements in electric lighting fuses or cut-outs.** John MacKenzie Urquhart and William Henry Dingle, 23, Bucklersbury, London.

9284. **Improvements in automatic apparatus for switching gear of electrical transformers and other electrical circuits.** Alfred Henry Walton, 17, South-street, Manchester-square, London.

9288. **Improvements in telephonic receivers.** Alexander Marr, 70, Market-street, Manchester.

9289. **Improvements in and connected with the electro-deposition of copper.** William Edwin Heys, 70, Market-street, Manchester. (Emilien Dumoulin, France.)

9332 **Improvements in and connected with permanent electric ways.** August Rincklake, 22, Glasshouse-street, Regent-street, London.

9362. **Improvements in dynamo-electric machines.** William Brooks Sayers, 46, Lincoln's-inn fields, London.

SPECIFICATIONS PUBLISHED.

1891.

8575 **Generating electric energy for lighting, etc.** Tesla. (Second edition.)

1894.

21838*. **Electrolysing chemical combinations, etc.** Bein. (Amended specification.)

1895.

7152 **Writing by telegraphy.** Faber.

8583. **Railway electric signalling apparatus.** Berry and Lipkowski.

9388. **Arc lamps.** Crompton.

9546 **Electric railways.** Lachmann.

10448. **Secondary batteries.** Falero and Lumley.

10655. **Arc lamps.** Binswanger and Angold.

10929. **Electrolysing chloride solutions.** Hermite and others. (Second edition.)

11181 **Electric switching apparatus.** Edmunds.

11355. **Electric cables.** Edmunds.

11659 **Secondary batteries.** Niblett.

12311. **Electric railways and tramways.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

12719 **Incandescent electric lamps.** Estrade.

20964 **Controlling electric motors.** Devonshire. (Potter.)

21924. **Wattmeters** Hummel.

1896.

1006. **Electric resistances.** Zinner.

1992. **Arc lamps.** Bagnall and Arnold.

4805. **Magnetic separation.** Wetherill.

4807 **Monocyclic electric generators.** Devonshire. (Thomson.)

4817. **Arc lamps.** Lavens.

5295. **Arc lamps.** Seaverns.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1⅛-1⅜
——— Non. Cum., 6 per cent. Pref.	2	1⅝-1¾
——— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	7½-8
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7½-7¾
——— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14½-15½
——— 6 per cent. Cumulative Pref.	10	16½-17
——— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	41-43
——— 4 per cent. Debenture Stock	100	133-135 xd
——— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
——— 6 per cent. Cum. Pref.	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1½-1⅝
——— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	1⅝-1⅞
——— 7 per cent. Cumulative Pref.	2	2-2¼
Elmore's Copper Depositing	2	⅛-¼
Elmore's Wire Company	2	⅛-¼
Fowler-Waring Cables	5	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	16½-17½
——— 7 per cent. Preference	10	16½-17½
——— 4½ per cent. Debentures	100	108-113
House-to-House Company, Ordinary	5	3⅛ 3⅜
——— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	23½-24½
——— 4½ per cent. Debentures	100	—
Kensington and Knightsbridge Ordinary	5	8½-8¾
——— 6 per cent. Pref.	5	7½-7¾
Liverpool Electric Supply, Ordinary	5	7⅝-7¾
Liverpool Overhead Railway	10	14-14½
——— 5 per cent. Pref.	10	16⅜-16¾
——— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	⅝-¾
Metropolitan Electric Supply	10	13-14
——— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7½ 8¼
——— 6 per cent. Cum. First Pref.	10	16-18
——— 6 per cent. Cum. Second Pref.	10	16½-17½
——— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
——— 3½ per cent. Deb. Stock	100	108-111
Notting Hill Company	10	9-9½
Oriental, Limited, £1 shares	1	1½-2
——— £5 Shares	5	8½-8¾
——— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	9/16-11/16 xd
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¾-5½
St. James's and Pall Mall, Ordinary	5	10½-10¾
——— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	38-41
——— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	6	8½-8¾
Westminster Electric Supply, Ordinary	5	9½-10
Yorkshire House-to-House	5	7-7½

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NOTES.

Dynamo and Transformer Construction.—Mr. James Swinburne, M.I.E.E., will commence a course of lectures on this subject on June 2 at the Electrical Standardising, Testing, and Training Institution, Charing Cross-road.

Another Exhibition.—We have received the *Boletin de la Union Industrial Argentina* for April. It deals with the trade of the Argentine Republic and Bolivia, etc., and discusses editorially the question of an industrial exhibition at Buenos Ayres.

King's College.—The annual dinner of old students of King's College, London, has been fixed to be held at the Holborn Restaurant on Monday, June 29. Sir Benjamin Baker, K.C.M.G., F.R.S., president of the Institution of Civil Engineers, will take the chair.

Telephones.—The *Daily Mail* says that it is in contemplation to lay down wires so that it will be possible to erect temporary telephone stations in the Mall and in Birdcage-walk in connection with the palace on drawing-room days, so as to greatly facilitate and abbreviate the business of calling the carriages.

A Present from the Sultan.—It is stated in the Constantinople newspapers that the Sultan has ordered an electric motor launch, built at the Imperial dockyard at Constantinople, should be presented to the Prince of Bulgaria. And yet there are people that complain that the Sublime Porte is not up to date.

Telephone Poles.—The *Zeitschrift für Elektrotechnik*, in the course of an account of the central telephone exchange at Brünn, in Moravia, describes the poles used to carry the wires in the neighbourhood of the exchange. These are iron constructions of the lattice type. They are over 50ft. high, and carry about 120 lines on 12 cross-pieces.

Royal Institution.—The Duke of Northumberland, president of the Royal Institution, has appointed the following as vice-presidents for 1896-97: Sir Frederick Abel, Lord Kelvin, Mr. George Matthey, F.R.S., Mr. Ludwig Mond, Earl Percy, Mr. Basil Woodd Smith, Sir James Crichton-Browne, treasurer, and Sir Frederick Bramwell, hon. secretary.

Pamphlets Received.—We have received "Lighting, Heating, and Cooking," a reprint of articles in the *Sanitary Record*, and note that in it the sanitary advantages of electric cooking are insisted on. We are also in receipt of *Compressed Air*, a new American monthly, whose title indicates the subject with which it deals. The English office is 114A, Queen Victoria-street.

Telephone Working.—The *Elektrotechnischer Zeitschrift* of May 7 devotes its "Review" to Mr. Dane Sinclair's paper at the Institution of Electrical Engineers on the working of a telephone exchange. A summary of the paper and discussion is given, but our contemporary has little to say editorially on the subject. Mr. Preece's remarks on the excellent working of the Berlin telephone exchange are, of course, duly noted.

Paper Poles.—It is possible to make a great many things out of paper, or out of a substance which is not paper, but can without any very great stretch of veracity be called so. We are therefore told in the *Moniteur Industriel* that telegraph poles may be made out of paper. The pulp is to be compressed hydraulically, and borax, salt, and other substances added. The advantages are to be lightness and durability. Unfortunately, these paper promises seldom come off.

Attenuating Toxines.—From the proceedings of the Imperial Russian Association of Industries it would appear that Mr. W. A. Tjurin has been repeating with success the French experiments on the attenuation of toxines by means of alternating currents. He states that under the influence of the current the virulence of diphtheria toxine can be so reduced that guinea-pigs inoculated with it show hardly any symptoms of its action, while if instead the untreated toxine is injected they die in a day. The attenuated toxine acts as a prophylactic and the animals inoculated with it cannot afterwards be made to contract the disease.

Units.—The *Journal Officiel* has published the order of the French Government fixing and rendering obligatory the use in all transactions in connection with the public service of the "electric units accepted practically by all the great nations." The obligatory units are the ohm (referred to a mercury standard "at the temperature of melting glass"), the volt (sufficiently represented by ·6974 of the E.M.F. o a Clark cell), the ampere, farad, coulomb, henry, joule, an watt. The unit of light is "the quantity of light emitted normal to the surface by a square centimetre of platinum at the melting point." Rules are given for the construction of the Clark cell.

Electricity in Theatres.—In the *Elektrotechnische Zeitschrift* there has appeared an exceedingly long article by Dr. O. Feuerlein on the use of electric light in theatres—that is, not for lighting the auditorium, but behind the scenes. Work done by Messrs. Siemens and Halske is described, and a quantity of incandescent lamps contained in metallic reflectors are figured. These are protected with wire network, just as though they were gas-jets—surely a superfluity of precaution. After a brief reference to the possibilities of the application of electricity to stage machinery, it is concluded that in the end an electric installation will be a necessity for every theatre.

A Telegraph Tale.—There are always a quantity of telegraph stories going about. The following one is represented as having been told by Sir Robert Low as an example of the difficulties he had with the field telegraph in the Chitral campaign. The native chiefs were at first rather suspicious of the wire, as they thought it was a mark for parcelling out the country among the soldiers, but on being told that it was to send messages to India they agreed to guard it. As, however, they did not see any messages passing along, they cut off a couple of miles of wire and took it away to watch the messages more at their ease. Their investigations were interrupted by the return of the engineers to see what had happened to the wire and why communications were cut.

Accident.—An accident, though fortunately not of serious character, appears to have happened in connection with the Portsmouth electric lighting on Sunday last According to the *Daily News*, a cabman named George Foote was passing an electric lamp column in Hyde-park-road, Portsmouth, "when the door of the column suddenly flew open and touched his head." Foote immediately fell, and was subsequently taken to the hospital. At the electric light works it is suggested that the accident was caused by gas escaping from the main finding its way into the electric lighting column, and being ignited by the spark caused by the contact of the automatic apparatus for switching on the incandescent lamps an explosion resulted, the door being forced opened and striking Foote violently.

Motorcarts.—The "International Exhibition of Motors, and Congress of Motor Industries, Horseless Carriages and Cars, Self-Propelled and other Vehicles, Cycles, Stationary Motors, Appliances, and Inventions" at the Imperial Institute was opened last Saturday. We have already referred to the

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chief features of this show in an account of the preliminary private view. It may be added that besides the motorcarts there are a quantity of "flying" machines. It is said that Mr. Maxim would have shown his entire apparatus if it had not been for fear of difficulties with the London County Council. If so, that body will again not be thanked. However, the engine is shown and a model on a small scale. The Prince of Wales was present in the evening. It may be mentioned that the Royal Agricultural Society will give prizes for light and heavy motorcarts at their next year's show.

Electrical Warfare.—Some time ago all the American papers that did not know anything of electricity were telling us of the terrible things to be done by Mr. Edison to the armies and fleets of any country that should dare to resist the Great Republic. The European nations were not greatly alarmed, and in France, where they have no proper reverence, there were some who laughed. But in Switzerland they have done better, though it has taken them some time. The *Journal de Genève* has just published a veracious discovery made there that bullets are diverted by the presence of telegraph wires carrying a current. Armour plates and fortifications will evidently go out of use when, with a few cheap telegraph wires, the enemy's shot can be turned away to the right and the left. Of the wonders of electricity, as reported in the non-technical Press, there is indeed no end.

Outside v. Tram Car.—The Dublin and Dalkey Tramway Company, while waiting for the permission of the Board of Trade to open the line, have taken advantage of the interval to train their motor men and conductors, and for this purpose the cars have been running daily, no passengers, of course, being taken. An outside car man, who naturally thought that there was nothing like horse-flesh, having observed the empty cars, remarked to his fare, "These new trams 'll never do." "Why?" was the inevitable question. "Sure, Sir, they've been runnin' them for the past month, and the divil a passenger they had at all; the public won't thrust 'em. And how are they goin' to pay their way at that rate. There's nothin' like an outsider, Sir." But perhaps he only wanted to delude an ignorant "Saxon" after all. To make anyone prefer an outside car because it was a "safe" conveyance would rank high in the scale of blarney even among such accomplished practitioners as the Dublin car men.

Institution of Civil Engineers.—A committee has been appointed to consider the question of the definition of a standard or standards of thermal efficiency for steam-engines, and the following gentlemen have been nominated members: Dr. Alexander B. W. Kennedy, member of council, and Mr. T. Hudson Beare, Mr. Bryan Donkin, Mr. James A. Ewing, Mr. J. Macfarlane Gray, Mr. Michael Longridge, Mr. W. H. Maw, and Mr. H. Riall Sankey. In connection with the Bill of the Government for power for the acquisition of land in connection with what is known as "the Parliament-street site," for the improvement and widening of Parliament-street and the obtaining of a site on which to build public offices, the institution has presented a petition, but they made no appearances against the Bill. Mr. Cameron, however, stated in the House of Commons last Monday a clause had been inserted for the protection of the institution, and the Bill was ordered to be reported to the House. The annual general meeting to receive the report and elect officers for the ensuing year will take place on June 2 at 8 p.m. The dinner of present and past students of the institution is to be held at the Restaurant Frascati, Oxford-street, to-day (Friday) at 7.30. Sir Benjamin Baker will preside. At next Tuesday's meeting papers on the magnetic testing of iron are to be read.

The Telephone Service.—Sir Blundell Maple having asked the Secretary to the Treasury, as representing the Postmaster-General in the House of Commons, if the Post Office was now prepared to give the same facilities for using trunk telephone lines, with respect to hours of service, etc., as existed previous to the Post Office taking over these lines, Mr. Hanbury replied that north of the Thames the former facilities remained, as the company still worked their old trunk wires. The facilities with respect to hours of service under Post Office control were now being given experimentally at certain places in the South of England, and the experiment was about to be extended. Until the result was known he would not be in a position to give any pledge as to a permanent arrangement, but there was strong reason to hope that the result would be satisfactory. This may be satisfactory to Mr. Hanbury, but will hardly be so to the general public. When a Government not only undertakes a business, but forbids anyone else doing so in competition, it is their obvious duty, if the public is not to suffer, to provide at least as good a service as any private undertaker would. Of course, a Government can always do this if it works on business lines, since it enjoys advantages which the private undertaking does not possess. If it were not so, it would be best for governments not to undertake such work.

Niagara in New York.—Last week, in mentioning the subject of the transmission of power from Niagara Falls to New York, we referred to the proposition to enable people at the electrical exposition in that city to listen to the "roar" of Niagara. We are again indebted to the New York *Electrical Engineer* for details as to what the American Telephone and Telegraph Company intend to do in this direction. It is said to be an often tested fact that over the long-distance wires, even now, although not arranged for the purpose, the noise of the falls can sometimes be heard, and the company are making plans so that several people can hear it distinctly at any hour and all at once. It is not necessary in making connection at the falls to go behind the sheet of water in order to get the full effect of sound, but by placing the transmitter near the Horseshoe on the Canadian shore all the tone and quality will, it is said, be clearly obtained. The receivers, to the number of 30 or 40, will be grouped around the little model of the Niagara power plant, on the special central platform, in the main hall of the New York Exposition, so that people will see Niagara run and hear it at the same time, the model itself being also driven with live or stored current from the falls, as explained last week. Mr. F. A. Pickernell, the electrical engineer of the American Telephone and Telegraph Company, is making the arrangments for this entertainment, which will be open to all visitors to the exposition.

A Registering Econometer.—In the *Revue Industrielle* there is a description of an Arndt econometer, to which is attached an electromagnetic registering apparatus. The Arndt econometer is an instrument for measuring the proportion of carbonic acid present in, say, chimney gases by weighing a fixed volume of them contained in a bulb against a quantity of air at the same temperature. The two bulbs are carried on the arms of a light and very sensitive balance, and the chimney gas being of a greater specific gravity than air at the same temperature, the gas bulb has an opening at the bottom and the gas is delivered into it by a tube passing through this orifice and sucked out again by an aspirator. The registering apparatus is of the usual type—that is, there are a quantity of circuits, one only of which is complete according to the position of a contact-maker carried on one of the arms of the balance. The

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circuit, when made, actuates a marker on a revolving drum by means of an electromagnet in the usual manner. It will be seen at once, however, that with a delicate balance such as is required there is no power to spare, and that the difference of weight on the two arms would be absolutely inefficient as a means of overcoming the friction of the contact-piece. The arms must hang free, and yet contact must be made. The difficulty is got over by making the contacts intermittent, the contact-maker being attracted by an electromagnet actuated by an intermittent current. A good momentary contact can thus be made, and yet the balance be left absolutely free to move up or down during the intervals between the contacts. Practice alone can show how such an apparatus will work, but the intermittent contact arrangement ought to act as a very efficient "dead-beat."

The Junior Engineers.—At the meeting of the Institution of Junior Engineers, held at the Westminster Palace Hotel, last Friday, the chairman, Mr. H. J. Young, presiding, a paper, "Notes on Belgian Electrical Engineering Practice," was read by Mr. A. Anstruther-Thomson and Mr. G. C. Allingham. The communication embodied particulars which had been collected by the authors during the institution's summer meeting of last year. Belgian electrical practice, the authors said, was difficult to define exactly. While it was usual to associate English practice, with high-speed engines direct coupled to dynamos or alternators, and Continental, with slow-speed engines driving multipolar dynamos; no rigid distinction existed. Belgian practice appeared strongly to exhibit both the foregoing characteristics, and was therefore extremely interesting as showing a variety of types, and affording exceptional opportunities for comparison. In contrasting English with foreign practice, the advantages of employing a consulting engineer over the foreign plan of giving the contract for the complete plant to some large firm were insisted on, and it was remarked that the system of free publication of central-station accounts to which in this country we were accustomed was not adopted in Belgium. Originally high-speed dynamos were driven from slow-speed engines by belts. To secure the advantages of direct coupling, in England the engine speed was increased, whilst on the Continent the dynamo speed was diminished. After briefly touching on the term "load-factor" and its influence on central-station practice, the preference shown on the Continent for continuous-current and large batteries was pointed out. Descriptions were given of some Belgian central stations, the Van Rysselberghe system at Antwerp and the application of gas-engines in sub-stations at Brussels being specially mentioned. The different types of plant in use in Belgium and England having then been dealt with, including boilers, engines, steam-turbines, dynamos, and batteries, it was remarked that with regard to electricity for power purposes there were no long-distance transmissions in Belgium, and hardly any multiphase plant, but the use of electromotors in workshops was steadily increasing. Several instances were given, notably the important installation at the Herstal Small-Arms Factory. In reviewing the question of electric traction, after referring to the Belgian experiments on accumulator cars, the trolley system, in which American designs are naturally largely employed, was considered, and descriptions of two Belgian electric tramways were given. The conclusion appeared to be that in electrical practice Belgium occupied a position intermediate between England and the Continent. The authors finally expressed their appreciation of the excursion to Belgium, and the hope that the institution would organise other meetings abroad; to their Belgian hosts their hearty thanks were due for the exceedingly kind reception which had been extended. A discussion followed, in which Messrs. H. B. Vorley, W. B. Clarke, F. M. Short, A. H. Dykes, T. E. Dowse, and K. Edgcumbe took part.

Rontgen Radiations.—A curious report has appeared in the *Standard* with reference to the possibility of the Röntgen rays being directly visible. On physiological grounds it is exceedingly unlikely that they should be so, but since they affect the photographic plate it is not absolutely impossible that they should likewise affect the retina, and it must be remembered that the *Standard's* Berlin correspondent, from whom the report comes, has hitherto been exceedingly accurate and up-to-date in all that he has telegraphed on the subject. Under normal circumstances Röntgen radiations would not reach the retina, since from the observations made by Prof. Salvioni and others it appears that the lenses of the eye are practically opaque to them. This fact, according to our contemporary, suggested to Dr. Brandes, of the University of Halle, the idea of trying what would happen with a lensless eye. It is stated that the experiment having been tried with a girl who had undergone the operation for cataract, it was found that the Röntgen rays were visible to her. It is stated that an aluminium plate was interposed between the eye and the Crookes tube, so that it would not appear that there could be any confusion between the Röntgen rays and the light of the tube, although from another part of the account of the experiment this would be inclined to suggest itself. It is further added that, if sufficient precaution is taken to exclude all ordinary light, the new radiations can be perceived by the normal eye, apparently being transmitted, not through the lens, but through the region of the sclerotic. Of course, there can be no question of "seeing" with the Röntgen rays, since there is no refraction and consequently no image. All that is possible would be a sort of undefined sensation of light. Considering how easily even a careful observer may deceive himself in experiments of this nature conducted with new and unfamiliar apparatus, it is evident that all results must be accepted with extreme caution. If, however, Dr. Brandes's observations are reliable, it is tantalising that our contemporary's correspondent should have missed the importance of telegraphing what the colour of the rays was, and in particular whether it was the same as the greenish-yellow light given off by the tube. For the rest, Mr. J. G. Stokes has written to the *Standard* to say that he has taken Röntgen photographs using the sparks of a Wimshurst machine instead of a Crookes tube. That was done before, when Prof. Röntgen's discovery was quite a new one. The American electrical papers still have a great deal to say on the subject so far as space is concerned, but very little of what is new or important. Everyone is ready to suggest this or think that, but no one seems to make any serious effort to grapple with the difficulties which beset each of the three or four theories that have been put forward as to the nature of the new rays.

Electric Traction on Railways.—We have several times referred to the contributions of Mr. W. Baxter to the American technical Press on the subject of the substitution of electrical for steam traction on ordinary railways. Mr. Baxter does not consider that this would result in any very large saving of coal. But writing in the *Scientific American*, he adds: "Investigation shows that the average cost of fuel consumed by American railroads amounts to about 10 per cent. of the total operating expenses; therefore, a saving of even half the coal would not be sufficient to justify the expenditure that would be necessary to equip a road electrically." On the other hand, there are indirect gains. "It would not be doing justice to electricity

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to assume that the only way in which it could reduce the operating expenses of a road would be by effecting a saving in coal, for such is clearly not the case. A little reflection will show that, if consumption of coal and water along the track is stopped, the wages of all men employed in preparing them for use can be saved, and also the cost of repairs to water-tanks, coal-bunkers, etc. It is also evident that the cost of keeping locomotives in repair is greater than the amount that would be expended on motors doing the same work. The boiler and tender have no counterpart in the electric motor, therefore all the money expended in keeping those parts of a locomotive in repair would have to be checked off in estimating the difference between the cost of maintenance of electric motors and locomotives." It seems to us, however, that the engines and boilers at the generating station will require looking after sometimes. Mr. Baxter further remarks that the smoothness of motion of the motor "ought to materially reduce the wear and tear of the rolling-stock as well as the roadway, and if the operation of trolley roads is anything to go by, the mileage of electric locomotives should be greater than that now covered by steam." The conclusion is that while it is far from certain that the net gain would be sufficient to pay the interest on the outlay that would be required to instal an electric plant on an existing railway, it might be enough to justify the adoption of the system for new lines. "Several branches of steam roads have been equipped electrically, and their operation has been so successful as to lead to the belief that in this direction electricity will obtain a foothold; but most, if not all, of these branches run light cars, about half-way between full-size steam cars and trolley cars, and therefore the results obtained on these branches are not a true indication of what could be done on the trunk lines with full-sized equipment." There is little to go by in America, and still less in Europe, as to what could be done with heavy traffic. In fact, the Baltimore and Ohio tunnel working is about all we have to judge from But Mr. Baxter thinks that this is fully sufficient to demonstrate that electric motors are capable of handling the heaviest kind of rail-road traffic, and if the future should show that they can do the work at a cost sufficiently below that of steam to render the saving in operating expenses 10 or 15 per cent., the prospects of the locomotive—at least, on new railways—will be anything but bright.

University of London.—In the House of Commons last week, Sir A. Rollit asked the Vice-President of the Council whether it was intended to introduce a Bill in pursuance of the recommendations, with or without modifications, of the Gresham Commission for the reorganisation of the University of London; and, if so, when and in which House. In reply to this, Sir J. Gorst said the Bill was being prepared in the Privy Council Office, but had not yet received the sanction of the Government. When it had received that sanction it would probably be introduced in the House of Lords. In view of the prospects of a Bill introduced after Whitsuntide if there is any great amount of opposition to it, a letter to the *Times* written by Prof. Ramsay from Madeira is important. The letter is too long for reproduction here, but in it Prof. Ramsay says: "An amount of agreement, amounting practically to unanimity, has been arrived at amongst the various conflicting interests concerned, which would have appeared quite hopeless of attainment to those who had to take up the tangled threads of this intricate problem in 1892. Seldom on any great public question, involving many interests and affecting many institutions, has so remarkable a consensus of opinion been expressed as that which was submitted to the Duke of Devonshire by the deputation which waited on him in November last, when the accredited representatives of the various bodies concerned, hitherto at hopeless variance amongst themselves, united in asking for a Bill, similar to that introduced by Lord Playfair under the late Government, to give effect to the recommendations of the Gresham Commission. The fragment of doubt suggested by the Duke as to the true meaning of recent votes in the Convocation of London University, to which it appeared to the deputation at the time that exaggerated importance was being attached, has now been removed by the decisive vote in Convocation itself, and no obstacle now remains in the way of a settlement of this long controversy by the addition to the present examining functions of the London University of those teaching functions which will convert it into a university worthy of its name and of the Metropolis of this great empire." The difficulty, of course, is to decide what difference, if any, should be made in the examination between resident and non-resident students. In this respect the recommendations speak for themselves. They leave it to the Senate, after consultation with the Academic Council and the standing Board, to decide to what extent the examinations shall be the same for both kinds of student. They contemplate, as a possible arrangement, that the examinations shall be wholly the same, but lay it down, as the extreme limit of diversity, that the final examinations, at any rate, shall be identical for both so far as identity may not prove to be prejudicial to either. Such a solution Prof. Ramsay considers should satisfy the advocates of either view. "It would have been unwise for the Commissioners to express themselves more rigidly on a point as to which strong difference of opinion among experts calls for some elasticity of treatment, while their main object would have been defeated if they had not insisted on conditions which will insure the indispensable identity of qualification. The interests of the external student will be safeguarded by the existence of a special board to take charge of them; those of the internal student will be safe in the hands of the Academic Council." A meeting of convocation of the university on Tuesday last was not without its absurd side. It seems that the examiner is fallible after all, and that at the University of London the examiners have been most grievously invading the province of the examinee, which is to make blunders. Anyhow, Mr. H. J. Harris, B.A., in moving a number of resolutions recommended by the Annual Committee, chiefly with respect to the new syllabus in mathematics, remarked that it was a disgrace to the university "that in four questions there should have been eight errors," and to his knowledge grievous injustice had been done to candidates who had failed to pass, largely in consequence of this discreditable blundering. Mr. Harris did not propose to examine the examiners, but one of his resolutions was, "That some means should be devised for a more thorough preliminary investigation than has hitherto been usual of the mathematical questions proposed to be set in the university examinations." Sir. A. Rollit, M.P., deprecated the taking of a division on such a subject. Of course, this is just the sort of thing that a great many people think should never be confessed openly, and an animated discussion followed. Dr. Silvanus Thompson has had something to say on the subject before, and now, naturally, strenuously supported the resolutions. The evil, he said, was understated, and the number of blunders in papers on mixed mathematics and other subjects was an absolute scandal; there were even errata in the errata. Ultimately, Mr. Harris's resolution was agreed to by a large majority.

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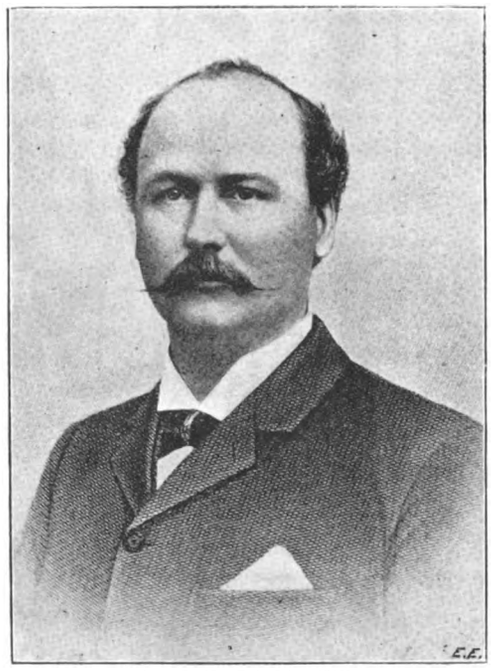
DUBLIN ELECTRIC TRAMWAYS.

The electric tramway between Dublin and Dalkey, which has been equipped by the above-named company, is one which will form a striking landmark in the history of electrical railways in this country. The line, which at present is not connected to the heart of Dublin, commences at Haddington-road, about half a mile from the centre of the city. From there it runs to the Royal Irish Society's show grounds, Ballsbridge, at which point the generating station of the company has been erected. The line then passes along Salisbury-road, through Merrion and Booterstown, to Williamstown and Blackrock. In this last extensive suburb a sub-station, as at Dalkey, has been erected. Onward from this point the line becomes most romantic in its surroundings. The sea view on one side is enhanced by the lovely country traversed as the line passes through Monkstown and Kingstown to Sandycove and Dalkey. At Sandycove a splendid view of the small harbour there is obtained, and the end of the line at Dalkey is surrounded by picturesque ruins.

MR. GEO. WHITE,
Chairman of the Dublin Southern District Tramway Company.



MR. J. CLIFTON ROBINSON,
Managing Director and Engineer to the Company.

The history of the tramways has been marked more by the fighting spirit of the Irish nation than by a desire to provide for the convenience of the public. The eight route miles of line were originally owned by four distinct companies, each running its own independent section, so that a passenger in going from Dublin to Dalkey had frequently to change cars no less than three times. There was also a change of gauge, so that even on holidays through cars could not be run. While this fighting *régime* lasted profit and progress were impossible, and the first object of the new directorate when

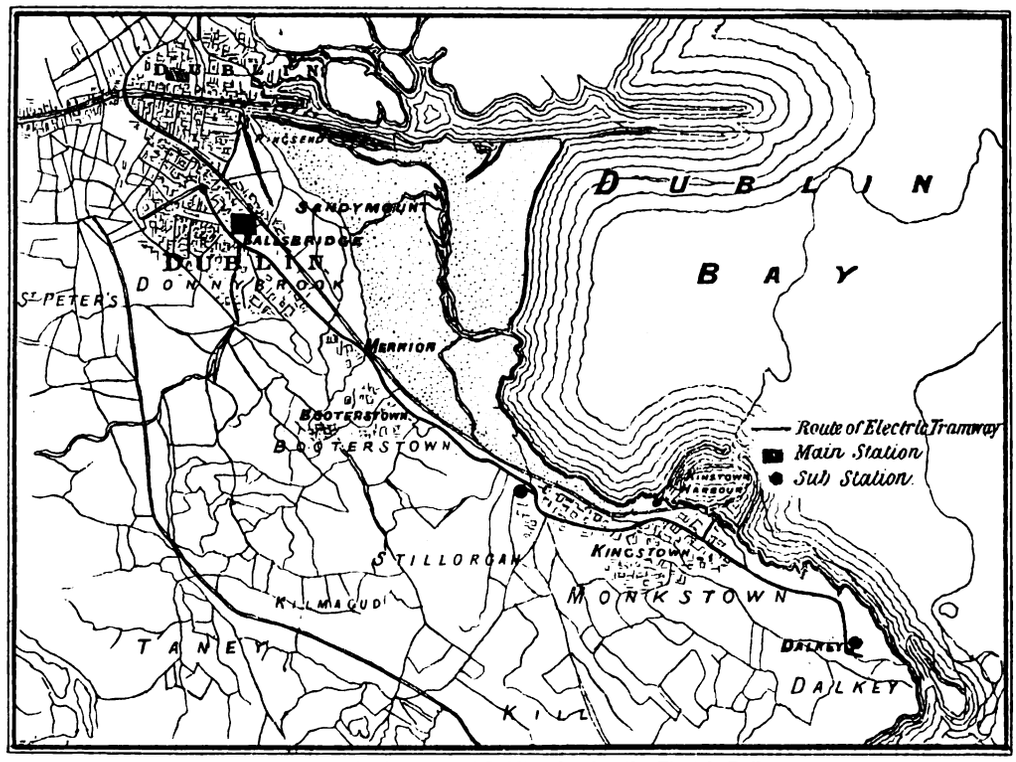


FIG. 1.—Map of the Environs of Dublin, showing the Electric Railway.

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they obtained control of the lines in 1892 was to inaugurate a regular through traffic with through fares. Though they were hampered by the disadvantages of horse traffic and a correspondingly slow service, the working soon showed a profit. The new directors, under the able chairmanship of Mr. George White, of Bristol, then determined to equip the line electrically on the overhead trolley system, and in 1893 obtained legal and parliamentary powers to enable them to introduce electricity on their lines. The work of reorganising and converting the tramway was placed in the energetic hands of Mr. Clifton Robinson, managing director and electrical engineer to the company, assisted by Mr. H. F. Parshall as consulting engineer. The fame of the latter gentleman as an electrical designer in America will assure the general reader that the electrical equipment of the line would be well carried out. In this work Mr. Parshall has included a three-phase transmission of power which forms the first extensive application of this system in the United Kingdom. Mr. Clifton Robinson's well-known skill as an organiser and his indomitable spirit in the face of opposition have been strongly brought out at Dublin. No expense has been spared to make the civil engineering work in connection with the laying of the permanent way a success, and the whole equipment of the lines has been provided for on the broad-minded policy that the convenience of the passengers and the easy travelling of the cars are the first desiderata. The civil engineering work has been carried out by Mr. S. G. Fraser, C.E.

FIG. 2.—Electric Trams at Monkstown.

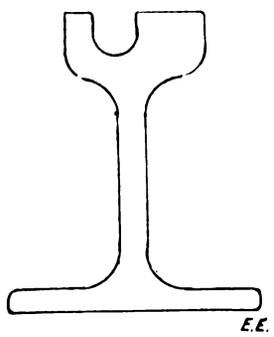

FIG. 3.—Section of Girder Rail.

The great sources of revenue to be anticipated from past experience in connection with the line are, first, the regular traffic of bringing business men from their suburban residences into the city of Dublin, and, secondly, the holiday and tourist traffic. The whole of the country passed through by the line in running from Dublin through Kingstown to Dalkey consists of a series of rich suburban districts, with gentlemen's houses standing in their own grounds. The outlook over Dublin Bay is one that has rendered this part of the coast exceedingly popular as a residential locality, hence, with a regular service in the morning and evening at five-minute intervals, with the fares given below, there is little doubt that a large and regular patronage on the part of business men will be acquired. The frequency of the service precludes the necessity of catching any individual car, and renders access into Dublin by tramway as speedy and certain as by the Dublin, Wicklow, and Wexford Railway. Moreover, when the extensions now under consideration by Parliament are passed—as most likely will be the case in a few weeks' time—the electric cars will provide convenient access to all parts of the city. The holiday traffic, judging from the picturesque surroundings of the line, not to mention the sea breezes to be enjoyed on the top of the cars, should be extensive, and a ride from Haddington-road to Dalkey at 4d.—*i.e.*, at less than ½d. a mile—will commend itself to residents and tourists alike. The following list of fares charged by the electric tramway and the corresponding railway fares will show the reader that the tramway company mean to provide for the public most liberally.

COMPARATIVE SCHEDULE OF FARES.

Dublin Electric Tramways Company.			Corresponding railway fares.		
Sections.	Present fares.	Old fares.	3rd-class single.	2nd class single.	1st-class single.
	d.	d.	d.	d.	s. d.
Haddington-road to Merrion	1	2	1	2	0 5
Merrion to Blackrock		2	1	2	
Blackrock to Kingstown		3	2	3	0 8
Kingstown to Dalkey		2	2	3	
Haddington-road to Blackrock	2	3	3	5	1 0
Merrion to Kingstown		5	3	5	
Blackrock to Dalkey		5	3	5	
Haddington-road to Kingstown	3	6	6	9	
Merrion Gates to Dalkey		7	5	8	
Haddington-road to Dalkey	4	8	8	10	1 4

Since the acquirement of the Blackrock and Kingstown Tramway in April, 1893, the average annual car mileage run is about 320,000 miles, while the number of passengers

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carried per year approximates at 1,500,000. The Dublin, Wicklow, and Wexford Railway Company carry on an average 6,000,000 per annum, while their annual mileage is about 1,000,000. The annual dividend paid on the Kingstown section averages 9½ per cent, against 1½ per cent. for the entire system, and the traffic on the Kingstown

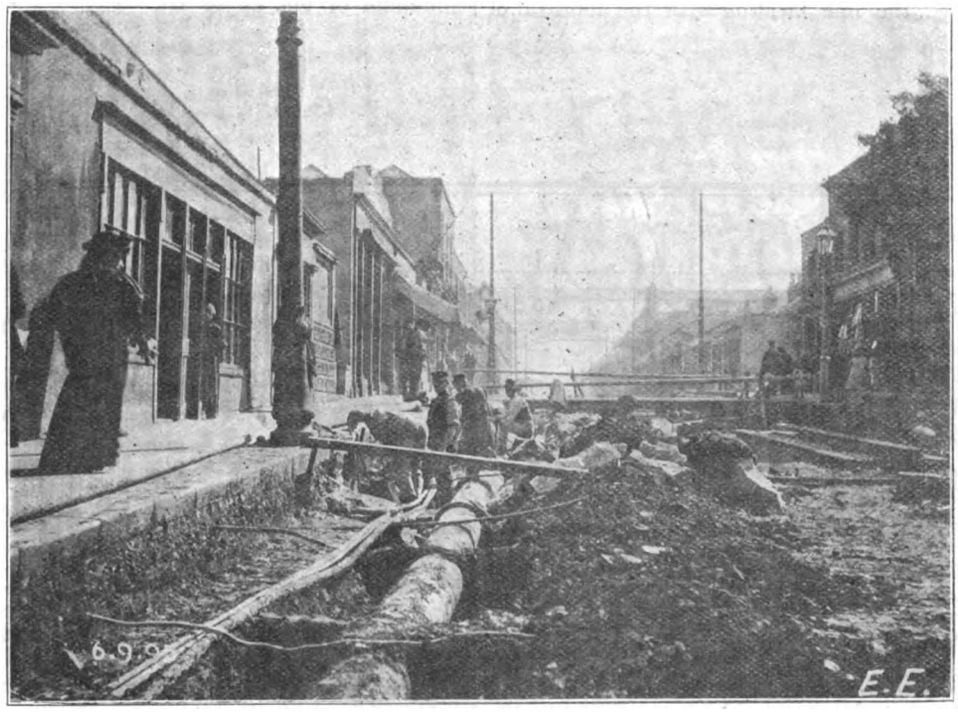

FIG. 4.—Excavation for Regrading the Main Street, Kingstown, showing Electric Feeders and Gas-Pipes.

Railway is said to yield a revenue of over £400 per mile per week.

GENERAL ARRANGEMENTS AND DESIGN.

The system on which the line is equipped is that of the overhead trolley so widely used in America.

wire being divided by sectional insulators. Along the full length of the line there is laid a feeder whose conductor has a sectional area of ·08 square inch. This feeder is connected to the half-mile section by means of the switch pillars placed at the foot of a post every half mile. The current in the trolley wire is supplied through this feeder at 500 volts. The feeder receives its supply at three points—*i.e.*, at the generating station at Ballsbridge and at the sub-stations at Blackrock and Dalkey. Instead of supplying these sub-stations by direct-current feeders, which would necessitate a large amount of copper, a three-phase alternating-current system has been adopted. The two

FIG. 5.—View of the Track at a Cross-over before the Granite Setts were laid

The latest and most approved practice has been followed generally, and as Mr. Parshall has been the consulting engineer we have a right to claim that in many respects the equipment is ahead of anything done on the other side. Thus the line, which is some eight miles long, is divided into half-mile sections, the trolley

alternators at Ballsbridge generate at from 2,000 to 2,500 volts, and the high-tension current is transmitted by two triple concentric cables to Blackrock and by one similar cable from Blackrock to Dalkey. The sectional area of the conductors in these cables is ·049 square inch.

At each of the sub-stations rotary transformers are used,

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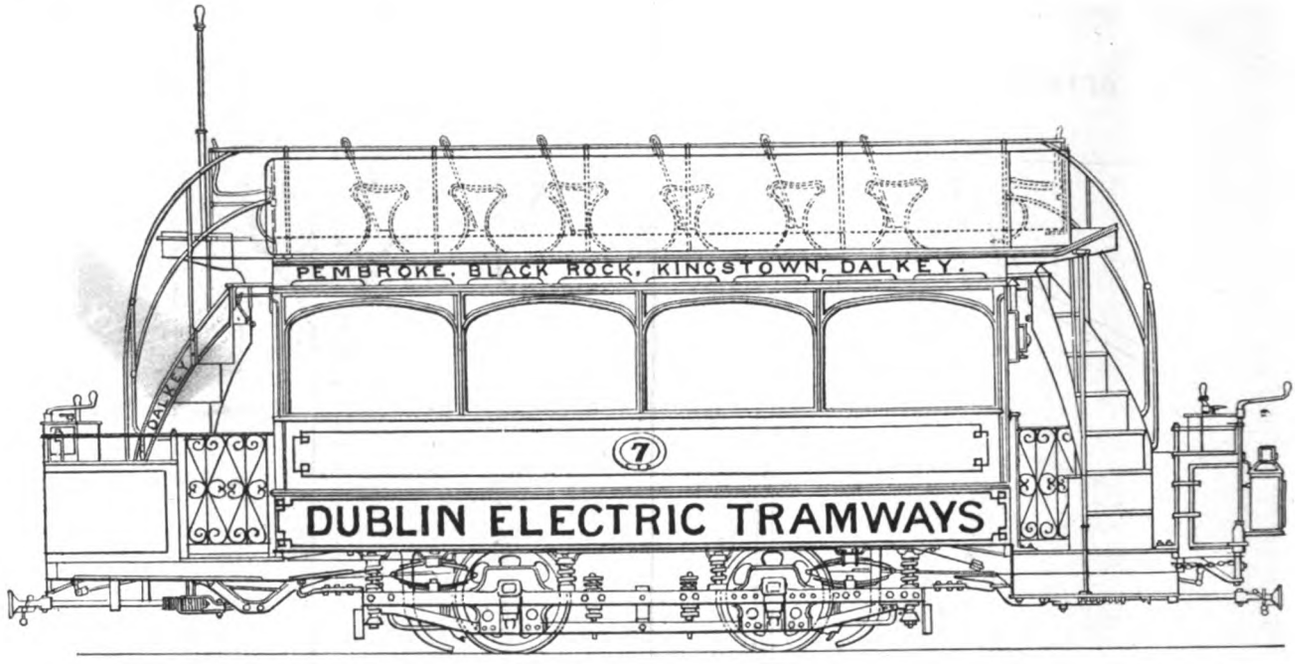
consisting of a 60-kilowatt three-phase motor direct coupled to an ordinary 500-volt direct-current dynamo. These dynamos supply the 500-volt feeders referred to above. The three-phase motors are synchronous, and hence well under control from the central station. The return circuit from the cars is made through the rails, which are carefully bonded with Chicago bonds. The careful attention to this work has ensured the line meeting with the approval of the Board of Trade. Thus it was found that the observed drop in volts on the rails between Ballsbridge and Dalkey when 50 amperes was applied at Dalkey agreed within 10 per cent. with the calculated value, and was well within the Board of Trade limit of seven volts. Both the tracks are bonded, and there are cross-bonds between them every 240ft.



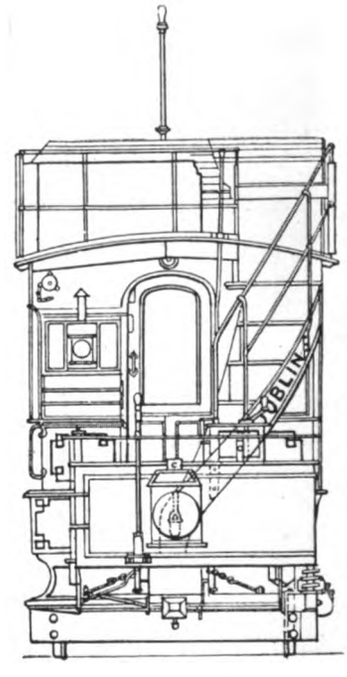
SIDE ELEVATION

FIG. 6.—Elevation of Motor Car used on the Dublin-Dalkey Electric Railway.

The contract for the whole of the work was placed with the British Thomson-Houston Company, and was directed from their head office in Parliament-street. The resident engineer in charge of the work has been Mr. C. W. G. Little, who, in spite of the various difficulties to be overcome, has carried it through most successfully.

CONSTRUCTION OF THE TRACK.

The first contract for this work was given to Mr. A. Krauss, of Bristol, but some dispute arising after the first few hundred yards had been laid the whole contract for the completion of the permanent way was placed with the Callender Bitumen Company on May 22, 1895. This contract included the removal of the old track, the excavation and new grading of the roads—the latter in many places necessitating the relaying of gas and water pipes. Besides this, the contract included the laying of the concrete bed, the supply and laying of the rail, and repaving. The gauge adopted is 5ft. 3in., which is the Irish standard, with 5ft. between the tracks. The rails are of the girder type, and are shown in section in Fig. 3. Substantial fishplates, weighing 25½lb. per pair, are used with eight bolts, the bond being placed clear of the fishplates. Tie-rods, weighing 14lb. each, connect the rails every 4ft. and maintain the gauge. These steel rails were specially rolled for Messrs. Callender and Co. by the Barrow Hematite Company. The spring points and crossings are of Marshall's patent design, supplied by Messrs. Askham Bros. and Wilson, of Sheffield. Sixty-two sets of points and crossings have been supplied for the work, which allows for four complete cross-overs per mile of double track. All the bending of the rails and blacksmith work were done on the spot. The worst curve on the line is one of 28ft. radius at the corner of Cassell-street, in Dalkey. The curve leading into the Royal Marine-road at Kingstown is of 31ft. radius. The worst grade on the line is one of 1 in 16 at Temple-hill, and there are short grades of 1 in 22, 1 in 24, and 1 in 30. After the roads had been regraded, as will be explained below, the concrete bed was made of broken granite from the old setts, mixed with Portland cement and sand or gravel crushings in the proportion of 6 to 1. The width of the concrete bed is 18ft., and the thickness varies from a minimum of 6in. up to 1ft. The bed was finally floated level with gravel and cement mixed in the proportion of 2 to 1. On this the granite setts are bedded in sand. The enormous quantity required will be gathered from the fact that 16,000 tons of trimmed granite has been supplied. The largest proportion of this came from Wales, being obtained from the granite quarries at Yr Eifl Llanaelhaiarn and Gwylwyr



END ELEVATION

FIG. 7.—End Elevation of Car.

y Wernnevan, near Carnarvon. A good number of setts were also obtained from Aberdeen and Dalbeattie, and a few hundred tons of Irish setts have also been used. The permanent way was grouted in with cement in most places, but at Kingstown pitch was used. The whole of the new track could easily have been completed in August last had it not been for the sewerage works carried out by the Kings-

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town Commissioners. The Commissioners had been for years under the obligation to construct a new line of sewers, and awoke to action in the matter when a certain proportion of the work of the tramway had been completed.

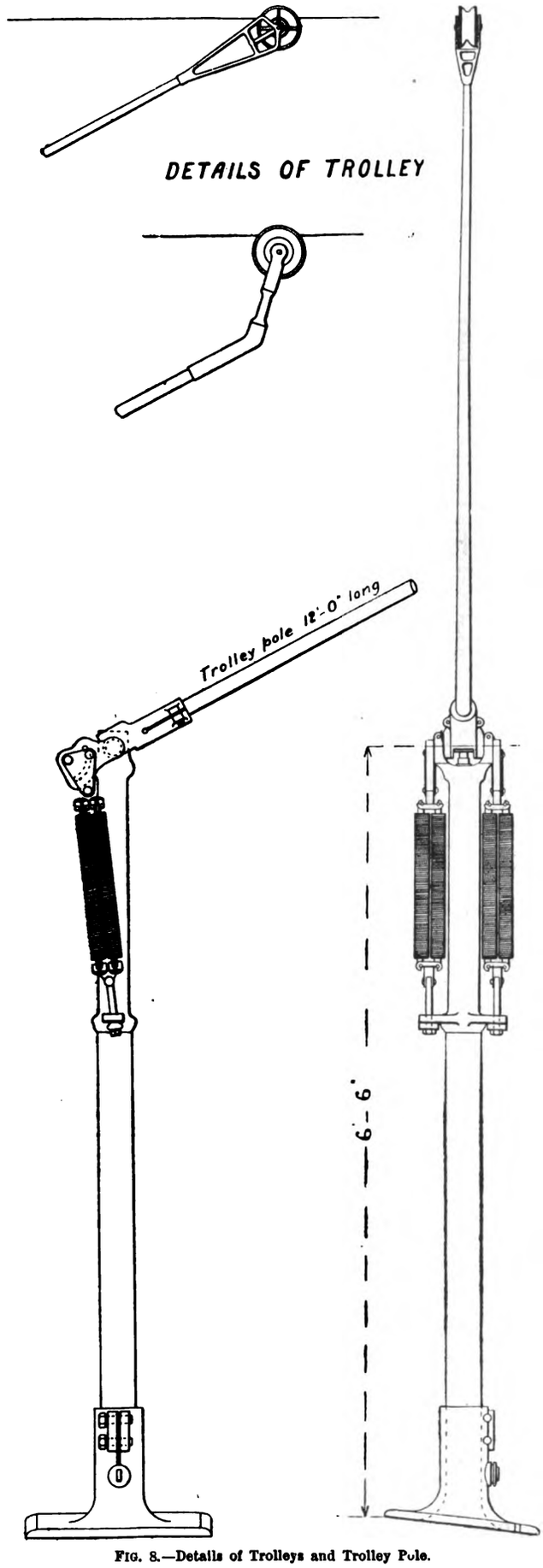

FIG. 8.—Details of Trolleys and Trolley Pole.

They had before this used the rights they had obtained over the tramway company to compel the latter to regrade the whole of the main street in Kingstown. The extent of this work will be gathered from the fact that the road was raised over 3ft. in Longford-place, and at other places, notably in Upper and Lower Green-street and Glasthule, the roadway was lowered an equal amount. When this work had been fairly proceeded with, the Commissioners commenced to lay their sewer, and the subsidence of the soil used to fill in the trench caused no small amount of trouble to the tramway engineers. From insufficient ramming and want of watering in the filling in, the soil proved utterly useless as a support for the concrete bed, and granite piers had to be erected,

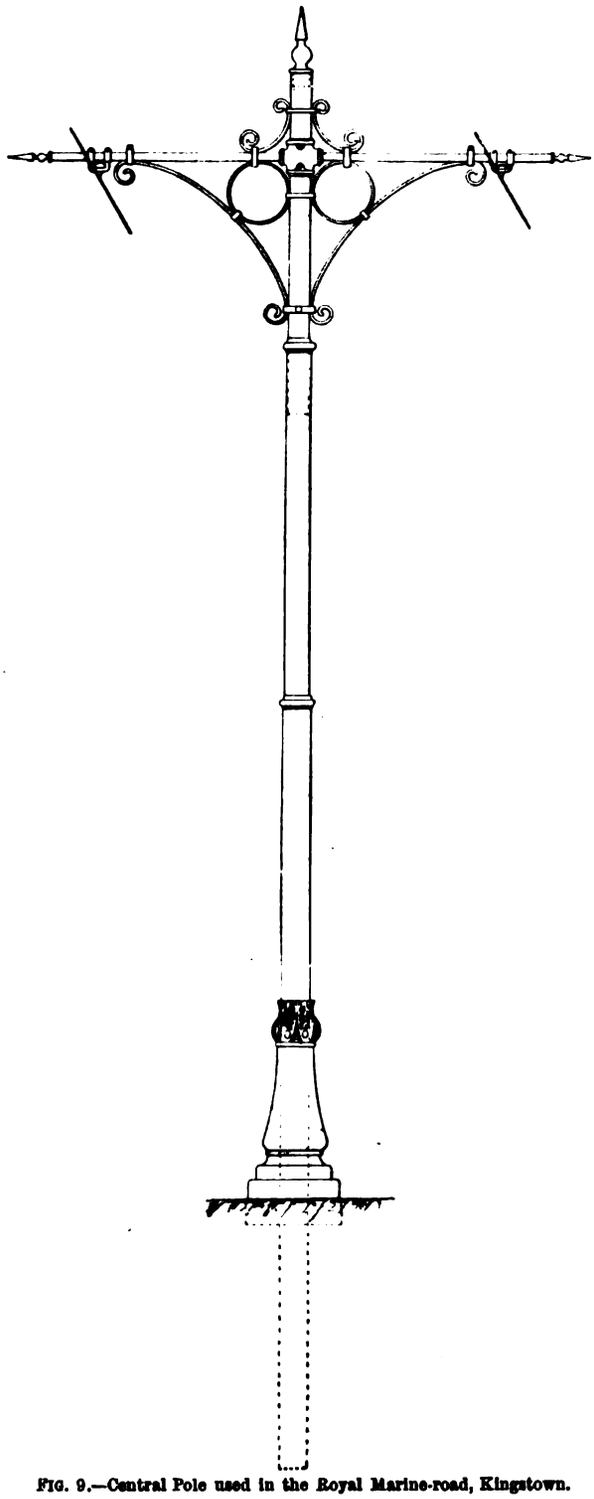

FIG. 9.—Central Pole used in the Royal Marine-road, Kingstown.

across which were placed pieces of old tramway rails to bear the weight of the new track. Through the whole of Kingstown the concrete bed had to be made 1ft. thick on account of the difficulty arising from the sewage works. In many places in Kingstown, in the new grading of the road, a large amount of rock had to be removed, and as, owing to the proximity of the houses, blasting was impossible, the process was exceedingly laborious. The whole of this work was carried out under the superintendence of Mr. T. Petersen, assistant manager of the Callender Company, with the help of Mr. Proctor and Mr.

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Sandiford. The whole of the labour employed has been local, and the number of workmen at one time amounted to over a thousand, of whom 500 may be described as having been on the regular staff. The total length of track laid is 15¾ miles, which, in addition to 1¼ miles of old track in Monkstown, brings the total length up to 17 miles. The difficulties met with in the construction of the line are well shown in Fig. 4, while Fig. 5 shows the rails at a cross-over before the granite setts are placed in position.

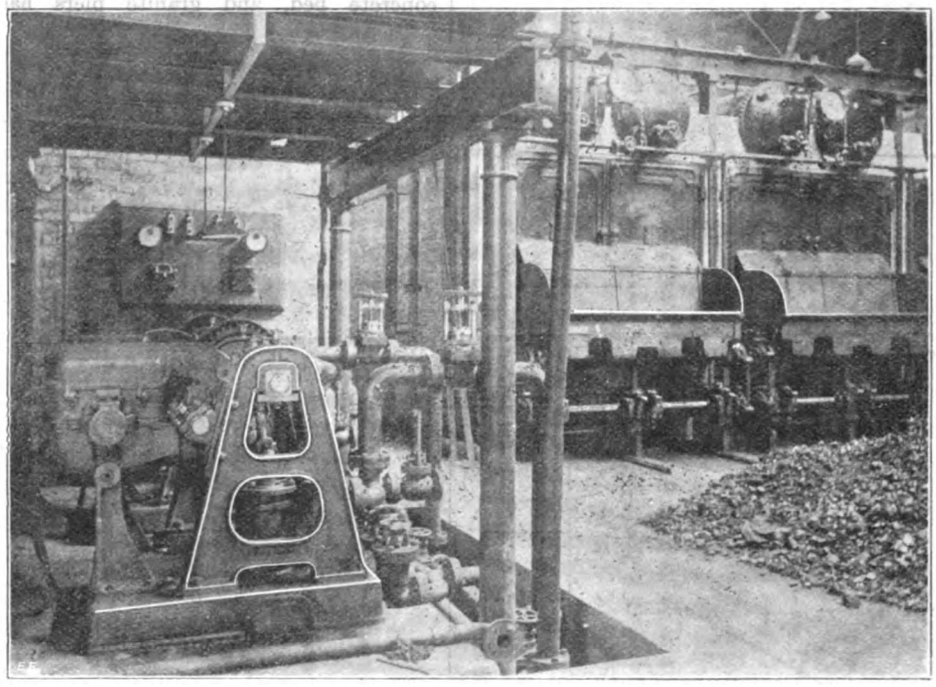

FIG. 10.—View of Boilers with Mechanical Stokers.

CONSTRUCTION OF THE MOTORCARS.

A view on a small scale of the car and trailer has been given in Fig. 2, but the full details of the cars will be more clearly seen in Figs. 6 and 7. It will be noticed that the cars and trailers are exceedingly roomy. The motorcars are built to accommodate 53 passengers, of whom 24 are carried inside, while the trailers have sufficient accommodation for 46 passengers—*i.e.*, 20 inside and 26 outside. The platforms at the back and front are well designed and give a separate entrance and exit for the inside and outside passengers. On the motorcars safety gates are also provided to prevent passengers boarding the cars at the end from which they are being driven. The access to the outside seats is easy, and electric bells are provided so that passengers on the top can stop the car at will. The cars are lighted by five incandescent lamps connected in series across the line, and in front of each motorcar a strong head-light will be carried after dark, which will illuminate the roadway for some distance ahead. A powerful hand-brake is fitted to each car, and in emergencies the motorcars can be quickly stopped by reversing the motors. The trucks are of the Peckham type, of which the general design will be seen from Fig. 6. They were manufactured for the contractors by Messrs. G. T. Milnes and Co., of Birkenhead. The motors used are of the G.E. 800 type, manufactured by the General Electric Company, of New York. They are guaranteed to give a horizontal effort of 800lb. with a 33in. car wheel when running at eight miles an hour.

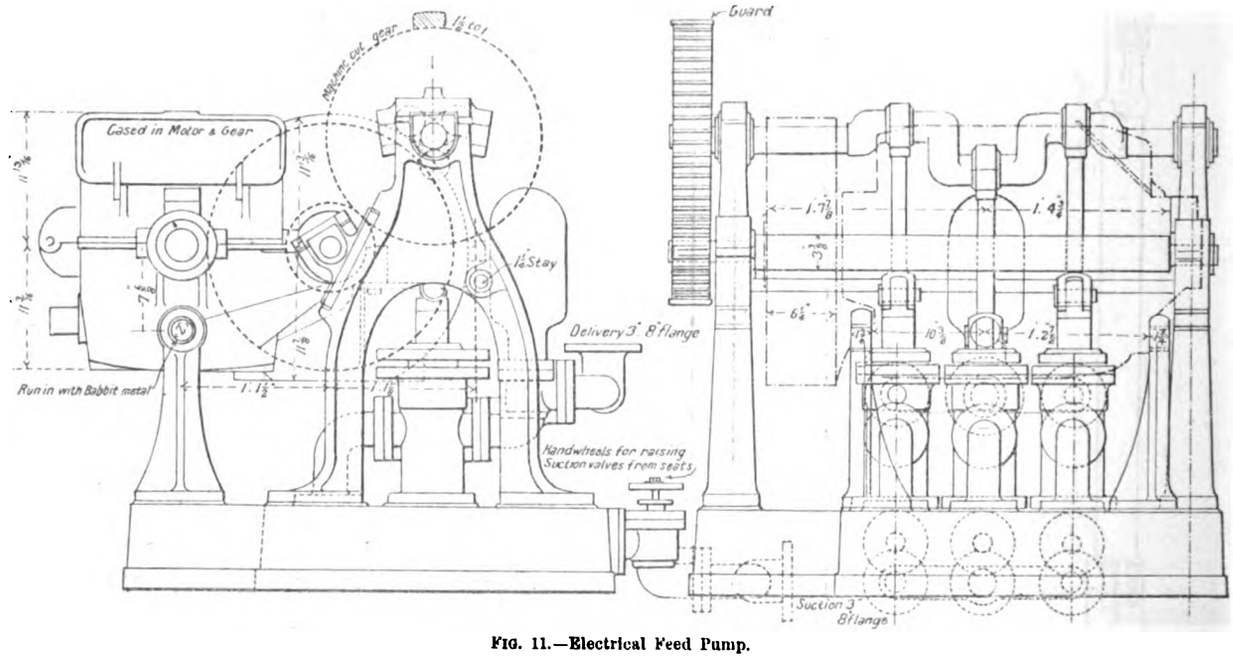
Guard
Cased in Motor & Gear
Run in with Babbit metal
Delivery 3" B'flange
Handwheels for raising Suction valves from seats
Suction 3" B'flange

FIG. 11.—Electrical Feed Pump.

Two of these motors are used in each motorcar. They are protected by a steel casing, which is made waterproof. By careful construction, the weight of these 25-h.p. motors, complete with gearing, etc., is kept under 1,600lb. The armature coils are insulated with asbestos, so as to be fireproof, and the whole armature is waterproofed. The gear reduction is 4·78 to 1, the pinion being of steel, gearing into an iron wheel. The gear is, of course, contained in an

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oil-tight case, and the lubrication has been made a special feature. The controllers used on the cars are of the General Electric K 2 series-parallel type, which have been described before in our columns. One of these is placed at each end of the car, and the driver always carries his handles with him. From an inspection of the working of these cars, for which we are indebted to the courtesy of Mr. Clifton Robinson, we are able fully to endorse the great value of these controllers, as with them the cars were always easily handled, and also the use of very large currents at starting was obviated. The trolley pole and trolley used at Dublin are shown in detail in Fig. 8. These trolleys in practice are found to work admirably, and on the severe curves found at Dalkey and Kingstown no trouble whatever has been encountered with them.

of hard-drawn copper, about ·325in. in diameter—No. 0 B. & S.—and, as explained above, it is divided into half-mile sections, and fed through switch-pillars from the 500-volt feeder which extends the full length of the line. Guard-wires are erected over the line wherever telegraph or telephone wires cross it.

Feeders.

The 500-volt feeder has been supplied and laid complete by Messrs. Callender and Co. The cable has been supplied in two sizes, one of $^{19}/_{\cdot 109}$ strand and the other $^{19}/_{\cdot 072}$ strand, the sectional area of the large cable being ·15 square inch and that of the smaller ·08. These cables are insulated with bituminised fibre, lead sheathed, yarned, and armoured by two steel tapes, and then yarned and

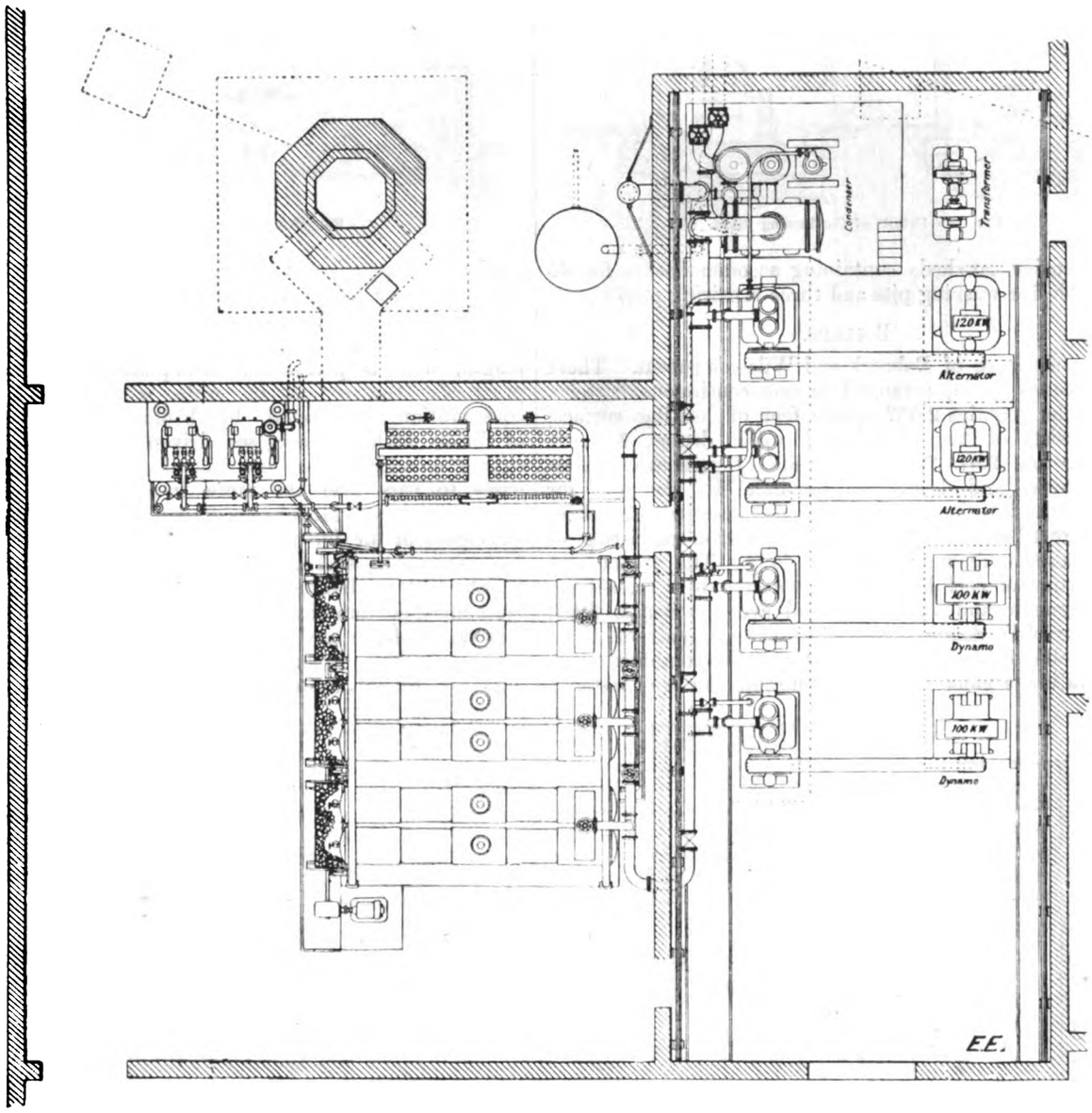

Fig. 12.—Plan of the Generating Station at Ball's Bridge, Dublin.

Overhead Construction.

With the exception of the Royal Marine-road, Kingstown, which is equipped on the central-pole system with poles as shown in Fig. 9, the whole of the overhead construction is arranged on the span-wire system. Two iron poles are placed one at each side of the road, and the span wire between the two, supports the insulators carrying the up and down wires. At the curves a second wire is often run between the two adjoining posts on the same side of the road, to keep the trolley wires approximately over the centre of the track. This can be seen in Fig. 2. The poles at the side of the road are made of steel tubes of three different sections, shrunk together at the junctions. They are bedded in concrete, a cast-iron base and foot-plate being fitted over the lower end of the pole. The span wires are mild steel, §in. in diameter. The trolley wire is

compounded over all. The steel tape used has been most carefully selected, in order to have great powers of resisting penetration. The factory lengths are jointed in cast-iron joint-boxes, so that a continuous iron sheath is provided throughout. Sixteen switch-pillars have been provided by the same firm, and the cable is looped into them, and not connected by means of T joints. Eight thousand yards of the larger-sized cable have been used, and 6,200 yards of the smaller. The larger-sized cable is used between Blackrock and Dalkey.

Pilot Wires.

The three-core pilot wire has also been laid by the same firm throughout the whole length of the line. Each conductor is a $^{7}/_{22}$ strand, and the three insulated cores are laid up together, lead-sheathed and armoured. This cable is used for testing purposes and to provide tele-

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phonic communication between any section of the line and any sub-station. The whole of these mains, together with the high-tension alternating main referred to below, have been laid in a trench running along the footpath (see Fig. 4).

Generating Station.

The main generating station is situated at Ballsbridge adjoining the River Dodder, water from which will be used for condensing purposes. The station consists of a boiler-room, engine-room, accumulator-room, as well as workshops

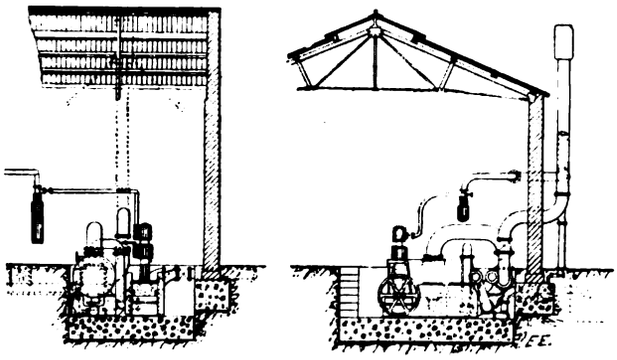

Fig. 13.—Details of Condensing Plant.

and extensive car-sheds containing accommodation for 46 cars, with five washing pits and three repairing pits.

Boilers.

The boilers are of Babcock and Wilcox's patent. There are three of them, arranged in one continuous battery. Each boiler contains 2,437 square feet of heating surface, and consists of two steam and water drums, 36in. in diameter and 23ft. 7in. long, made of mild-steel plates $\frac{13}{32}$in. thick, and having a manhole at the rear for access to the interior of each drum. Suspended from these drums are 12 sections of tubes, each section consisting of nine tubes 4in. diameter and 18ft. long. The steam and water drums of each boiler are connected by a cross-drum 20in. diameter and 72in. long, and every boiler is fitted with Turnbull's deadweight safety-valves, a pair of Dewrance's self-closing water-gauge fittings, two combined feed-check valves, a globe valve for regulating the feed water, a 2in. blow-off cock of Hopkinson's make, and a Hopkinson's 7in. main steam stop-valve fitted on the top with a cross-drum. In addition, each boiler is furnished with automatic fixed soot-cleaning pipes for enabling the soot to be blown from the exterior of the tubes by means of fixed steam-jets, and the fronts are fitted with large-sized tube doors, giving access to the front headers. The boilers are constructed for a daily working pressure of 160lb. per square inch, and were tested after erection to 240lb. At the present time, however, the safety-valves are only loaded to 140lb. The boiler fires are fed by Vicars's mechanical stokers specially arranged to work with this type of boiler. The fuel is fed from a hopper into four boxes, from which it is gradually pushed by alternately reciprocating plungers into a fireplace. Then it falls on to the dead-plates, and goes from there to the firebars, which by a slow reciprocating movement carry the burning mass gradually backward. Such unconsumed coal as reaches the end of the grate bars, together with the clinker and ash refuse carried back, are discharged over the ends of the firebars on to a set of short

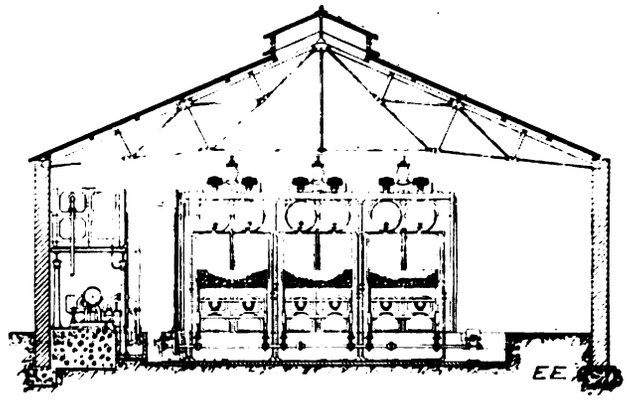

Fig. 15.—Front View of Boilers.

stationary bars, where they form up and maintain a bank, which acts as a bridge, closing the far end of the ashpit, and on which the combustion of the precipitated fuel is in due course completed. The firebars are about 3½ft. in length, with a perforated dead-plate 12in. long; thus practically the extent of grate is 4½ft. The smoke consumption is effected by baffling down by means of brick arches the gases driven off the fuel while coking is taking place on dead-plate, and causing these gases to pass over the more incandescent fire at the end of the bars. Means are also provided for ensuring a sufficiency of air for proper combustion. The supply of fuel and the travel of the firebars are regulated with facility, independently of each other, by means of a simple mechanical combination, for which motive power is required. The travel of the bars may be adjusted to any length, from a state of rest to a maximum of 4in. The alternate fire-bars are drawn towards the front of the furnace, and then all the firebars travel inward together. The motion is derived from an underground driving-shaft, upon which are keyed driving eccentrics, which act upon ratchet wheels and pawls, and give the necessary movement to stoker shafts, and by means of cams on these shafts the horizontal movements on firebars and plungers are effected. The speed of this motion can be regulated to from 30 to 120 turns of the shaft per hour. The furnace can, when required, be fed by hand through a doorway between the two pushing rams. The whole of the shafting working these Vicars's stokers is driven by an electric motor of the

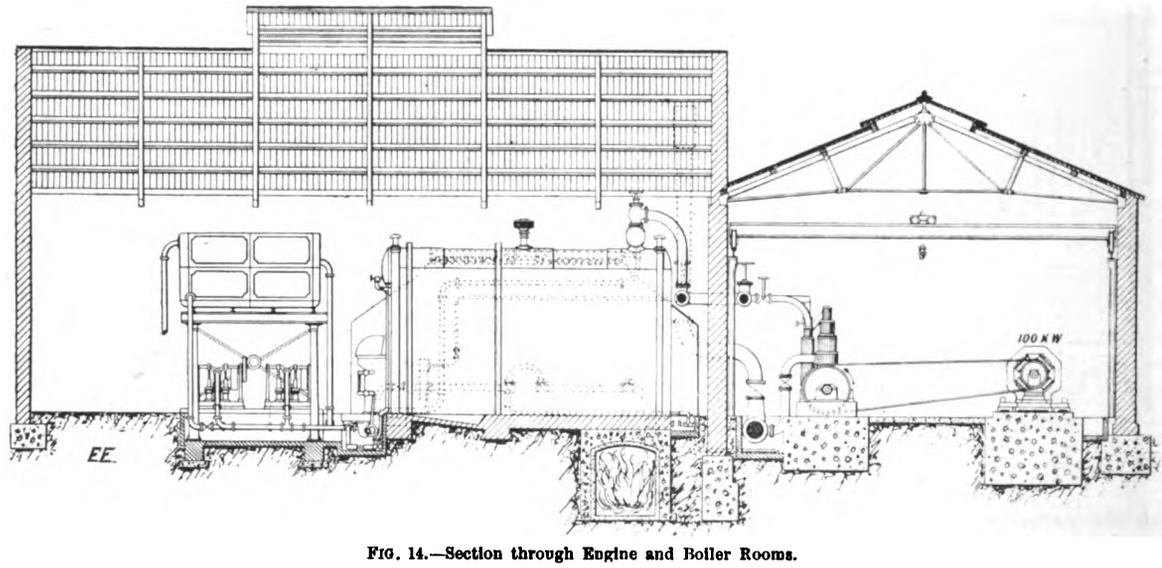

Fig. 14.—Section through Engine and Boiler Rooms.

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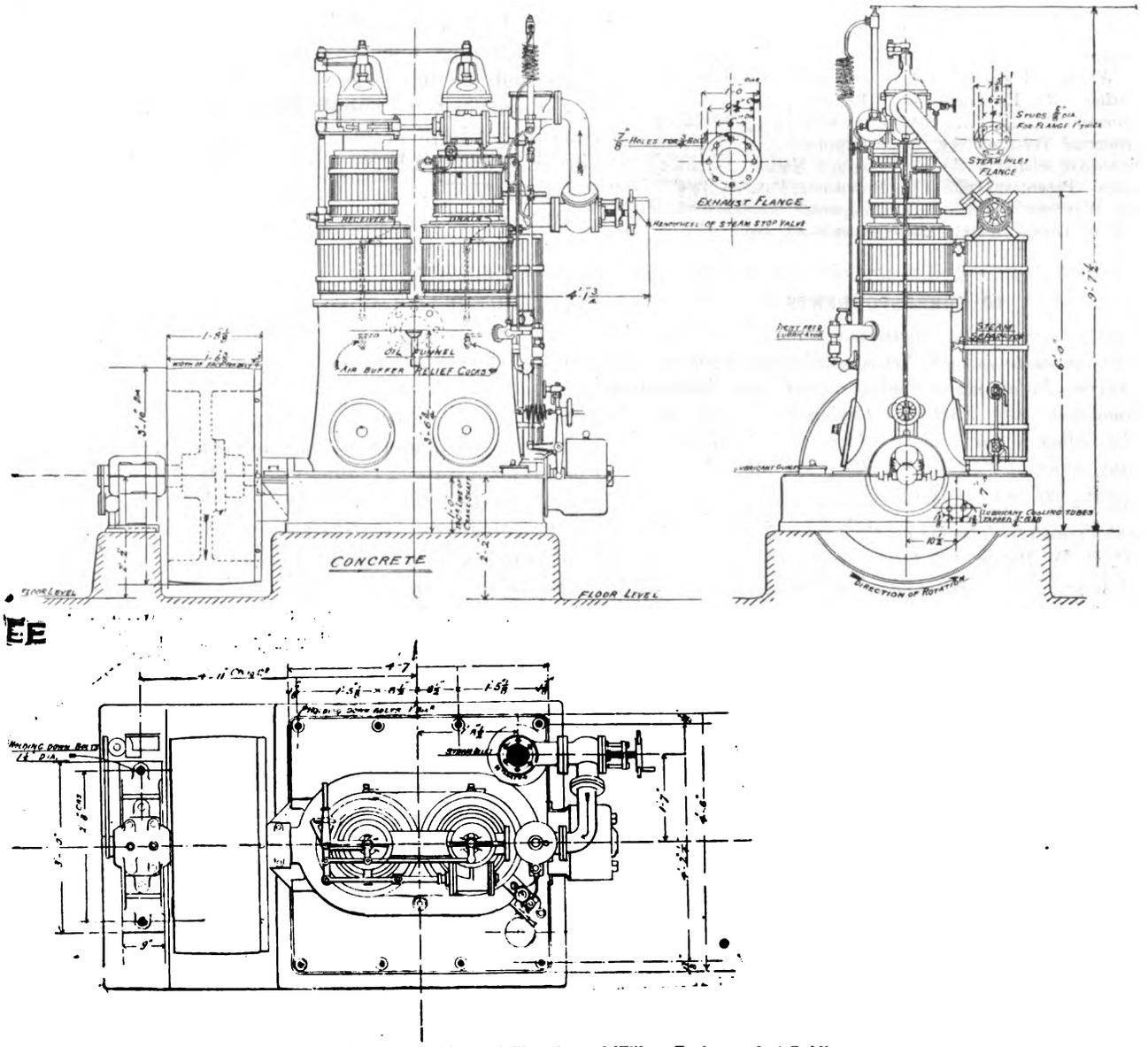
General Electric Company's make. The motor is, in fact, one of the type used for driving electric cars, but shunt wound. The dustproof case prevents the coal-dust from injuring the working parts. This electric motor is placed in a small pit at the right-hand side of the battery of boilers, and therefore cannot be seen in Fig. 10, which, however, shows the front of two boilers with the mechanical stokers in position. In the foreground of this illustration are shown the electrically-driven feed pumps. These have been manufactured by Messrs. Daniel Adamson and Co., and are driven by General Electric Company's motors. As will be seen in Fig. 11, the pumps are of the three-throw type, and the motors drive the crank axle through double-reduction spur gearing. These pumps are connected with a duplicate set of feed pipes, and separate feed arrangements

A straight line of cast-iron pipes is led to the condenser. This latter plant has been supplied by Messrs. Browett, Lindley, and Co., and is designed to be capable of condensing 19,000lb. of steam per hour. The tube surface of the condensers is 1,200 square feet. The plant consists of a pair of vertical single-acting air and circulating pumps, mounted on a cast-iron base-plate. The buckets are worked by links attached to an overhead beam mounted on a rocking shaft, which is supported on bearings between the pumps. The rocking shaft has at one end a lever, which is connected by means of a connecting rod to a crank-pin, mounted on a wheel on the engine shaft. The surface condenser is placed alongside the pumping plant, and has branches connected to the air and circulating pumps, and also a branch for connection to the exhaust



FIGS. 16 AND 17.—Plan and Elevations of Willans Engine used at Dublin.

are also provided by means of injectors. The feed water is heated by means of a Green's economiser, the scrapers for which are also driven by the same motor that works the mechanical stokers. The chimney shaft is 110ft. high, and 6ft. in diameter inside. The exterior is octagonal in shape. The chimney is lined 30ft. up with firebricks, and communicates with the furnaces by two 30in. flues.

STEAM AND EXHAUST PIPES.

The steam-piping is designed on the ring system, and has a liberal supply of Hopkinson's valves to isolate any defect that may arise, so that continuous working may be ensured. The main ring is constructed of mild-steel pipes, 8in. in diameter. The bends to the engine are made of copper. The arrangement of the exhaust-pipes can be seen in Fig. 12, which shows the plan of the station.

steam main, and a branch for circulating water discharge. The engine is of the vertical tandem compound E. L. type, with a 4in. crankshaft, and is fitted with an "Acme" governor. The following are a few of the dimensions of this plant: size of steam-cylinders, 7½in. and 12in. diameter by 10in. stroke of piston; air-pump cylinder, 12in. diameter by 12in. stroke of bucket; circulating pump, 24in. diameter by 12in. stroke of bucket (both these pump barrels are removable); the diameter of the exhaust branch is 16in.; the diameter of circulating water suction and discharge, 10in.; and that of the air-pump discharge, 6in. The 8in. suction buckets are of gunmetal, having a large area through for the passage of water and air, and are fitted with grey rubber valves and brass guards.

(Continued on page 547.)

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TWO SIDES.

It is not often that the Board of Trade say "no" to the request of a local authority applying for a provisional order, but this has occurred at Newington. An examination into the whole matter, however, will clear away surprise. In the first place, a provisional order is already in existence for a part of the district. In the second place, the decision of the Vestry was arrived at by the casting vote of the chairman. We are writing from recollection on that point, and are open to correction. In the third place, great opposition was manifested against the scheme when the enquiry of the Board of Trade was held. Neither of these circumstances, considered separately, might have been considered adequate to condemn the scheme, but the combination was fatal. Although we have been strenuous advocates for the local authority to supply artificial light, we cannot complain of the action of the Board of Trade in its decision as regards Newington. The local authority is the proper authority to do the work, but if the local authority does not take advantage of its opportunity, it ought not to be allowed to stand in the way of private enterprise. The waiting policy is suicidal. We shall all be dead and forgotten if we wait to act while certain people make up their minds. The time of Newington was before the first provisional order—that being granted, we take it, with the consent of the authority, support should have been given to the holders of the provisional order, instead of an attempt being made to filch that which had been granted. There are usually at least three parties to be considered in any attempt to light a district electrically. First we have those interested in gas, who, from a business point of view, can hardly be deemed to look upon the question with favour. Their opinions must be largely discounted. On the other hand, we have those interested in electricity, and their opinions are no less rabid and one-sided than those above named. A third party is unconnected with either gas or electricity, and ought to listen to both with respect and judge without bias. Unfortunately, the third party as a rule is conspicuous in keeping away from all meetings and proceedings when its opinion should have the greatest weight. "Oh, let them fight it out," is the cry, and so the result is too often a battle-royal between two interested parties. We have not cared to examine too closely into the local politics of Newington, but it is natural to assume that the chairman's vote was given because the interested parties were equally balanced and disinterested parties took little part in the matter. It has always been assumed that if a local authority took up the question the Board of Trade would decide in its favour, but we have perhaps recorded the exception which proves the general correctness of the assumption. Since humanity began to write, an axiom has existed that the important sentences of a lady's letter will be found in the postscript. Perhaps our real text may be similarly indicated at the close of this short article. How is it that men engaged in the electrical industry are so ready to cut one another's throats? There is scarcely a local authority, or a company, or a firm,

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or an individual commencing to look into the matter of electric lighting but is pestered with the attentions of men engaged by some other person than the one employed to look into the matter, these attentions being directed towards displacing the man in possession in favour of the nominee or master of the person who is so officious in paying attentions where they are not only not wanted, but which again and again work incalculable harm. The moral may receive point from an old tale. If we remember rightly, Portsmouth once had a consulting engineer, and that consulting engineer and his designs were superseded partly, if not wholly, because another engineer, unsolicited, went to the chairman of the committee and condemned the practically accepted designs. This was stated publicly at the opening of the station. We maintain that interfering action of this character is unprofessional, and has done and is doing harm. The petty squabbles that characterise many of the meetings of the authorities can be directly traced to the interference of members of the industry who are simply trying to oust the man in possession in order to get in themselves or to assist some member of their clique. This may be sharp practice, but it is not business.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

May 19, 8 p.m —At the Institution, Great George street, Westminster. "Magnetic Testing of Iron and Steel," by Prof. J. A. Ewing, F.R.S.; and "Magnetic Data of Iron and Steel," by Horace F. Parshall.

Institution of Electrical Engineers.

May 15, 5 p m.—Students' visit to Brook Green Works, Hammersmith.

May 22, 8 p m.—At the Institution of Civil Engineers, Great George-street, Westminster. Students' meeting. Paper on "The X-Ray Photography," by H. L. Tyson-Wolff (student)

Royal Institution of Great Britain.

May 15, 9 p m.—At Albemarle-street, Piccadilly. "Cable Laying in the Amazon," by Alexander Siemens.

May 19, 3 p m.—"Ripples." (Second lecture.) Prof. C. V. Boys.

May 22, 9 p.m.—"Hysteresis." Prof. J. A. Ewing.

Society of Arts.

May 18, 8 p m.—At John street, Adelphi. Cantor lecture. "Applied Electro-Chemistry," by James Swinburne.

May 19, 8 p.m.—"Bronze Casting in Europe," by George Simonds.

May 20, 8 p.m.—"Orthochromatic Photography," by Captain W. de W. Abney, C.B., F.R.S.

Physical Society.

May 22.—"On Dielectrics," by R. Appleyard. "The Field of an Elliptical Current," by J. Viriamu Jones. "An Instrument to Measure Frequency," by A. Campbell.

Royal Meteorological Society.

May 20, 7.30 p m.—At the Institution of Civil Engineers Paper on "The Exposure of Anemometers," by Richard H. Curtis. (A collection of photographs of clouds, by Mr. H. C. Russell, F.R.S., of Sydney Observatory, will also be exhibited.)

Liverpool Engineering Society.

May 16.—Visit to the Southern Extension Works of the Overhead Railway.

INSTITUTION OF ELECTRICAL ENGINEERS, May 14.

At last night's meeting of the Institution the following candidates were balloted for:

Associates.—A. S. Anderson, the Northern Electric Supply Company, Cults Generating Station, Aberdeenshire; Frederick Ernest Andrews, "Foxholme," Loughborough, Leicestershire; R. B. Johnson, 108, Elgin-crescent, Notting Hill, W.; Alfred J. Hollington, 28, Bush-lane, Cannon street, E.C.: James Patchett, Wellington, Shropshire; Frederick S. Pilling, Electric Light Station, Dagger-lane, Hull; Thomas Scott, 18A, Eldon-street, London, E.C.; John Henry Whittaker, 53, High-street, Dudley.

Student.—William Collins, "Oakville," Overcliffe, Gravesend.

DUBLIN ELECTRIC TRAMWAYS.

(Concluded from page 545.)

The surface condenser casing is of cast iron, fitted with covers at each end, and arranged with air-chamber pockets, and dividing ribs, to produce a sinuous flow of water through the condensing tubes and avoid shock. The tube plates are of Delta or Muntz metal, 1¼in. thick, and secured to flanges in the casing by means of brass screws. The tubes are of seamless drawn brass, ¾in. diameter by 5ft. long, and are fastened in the tube plates by means of screwed ferrules and tape packing. As has been mentioned above, the water for condensing will be taken from the River Dodder. An elevation of the plant is shown in Fig. 13, while Fig. 14 shows a complete section of the boiler and engine room giving the relative vertical positions of the exhaust and steam pipes. Fig. 15 shows the front elevation of the boilers with the mechanical stokers.

Engines.

Messrs. Willans and Robinson have supplied the engines for this important station. They consist of four engines of the H H compound type, and are designed to run at 380 revolutions a minute. The ordinary continuous load is 170 b.h.p., but the engines are capable of delivering 200 b.h.p. on occasion. They are fitted with variable expansion gear, which has been described before in our columns, the gear being automatically controlled by the governor. The diameter of the high-pressure cylinders is 12in. and that of the low-pressure ones 17in. with an 8in. stroke. Each engine is provided with a 3ft. 10in. flywheel pulley arranged with an outer bearing to prevent strain at the main bearing of the engine. These engines (shown in Figs. 16 and 17) drive the dynamos by means of 16in. belts.

Dynamos.

The dynamos and alternators have been supplied by the British Thomson-Houston Company. There are two direct-current railway generators with four poles, each capable of giving 100 kilowatts continuously or 120 kilowatts on emergency without sparking. These dynamos are fitted with carbon brushes and supply the current to the trolley feeders at 500 volts. These machines are compound wound, and are provided with equalising switches to connect across the compound winding when the two machines are working in parallel. These continuous-current dynamos are on the foreground in the general view of the engine-room, shown in Fig. 18. The other two engines are used to drive two 120-kilowatt, six-pole, three-phase alternators, working at a frequency of 30 complete periods per second. These machines have been manufactured at Messrs. Armstrong, Mitchell, and Co.'s works at Newcastle-on-Tyne, to Mr. H. F. Parshall's design. The low frequency is advantageous when the machines are to be used for transmission of power only, as in this case. These alternators are remarkable for the compact nature of their design, which is such as to give a high degree of mechanical strength and durability. The armature coils are buried in a laminated iron core after the usual practice of the company. The alternators are connected to the alternating-current motors at Blackrock and Dalkey sub-stations, as indicated by the general diagram of the line (Fig. 19).

Accumulators.

The battery of accumulators erected at Ballsbridge consists of 55 Epstein cells, of type R 11, each cell being composed of 11 electrodes (five positives and six negatives) contained in glass boxes. The battery was first charged last February, and is installed for the purpose of lighting the generating station. The capacity of the R 11 Epstein cells, at a rate of discharge of 65 amperes, is 10 hours, but they can be charged and discharged at very high rates without detriment to the plates, and the cells mentioned could upon emergency be discharged at 350 amperes during about one hour with perfect safety. This battery is charged by means of the continuous-current transformer shown in Fig. 20. It may be added that the gentlemen who appear in this illustration are Mr. Clifton Robinson, Mr. H. F. Parshall, and Mr. Robinson, jun. The transformer consists

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of a 30-kilowatt 500-volt motor, which is driven by the main dynamos and is directly coupled to a 125-volt continuous-current dynamo, which can be worked at a higher voltage for charging the accumulators. Besides being used for lighting the station, the accumulators in connection with the C.C. transformer are very handy for testing purposes. In one instance the high-pressure feeder was tested at an abnormally high voltage by this means. The batteries first supplied current at about 500 volts to the trolley wire, and this at the Blackrock sub-station was transformed up to 5,000 volts alternating.

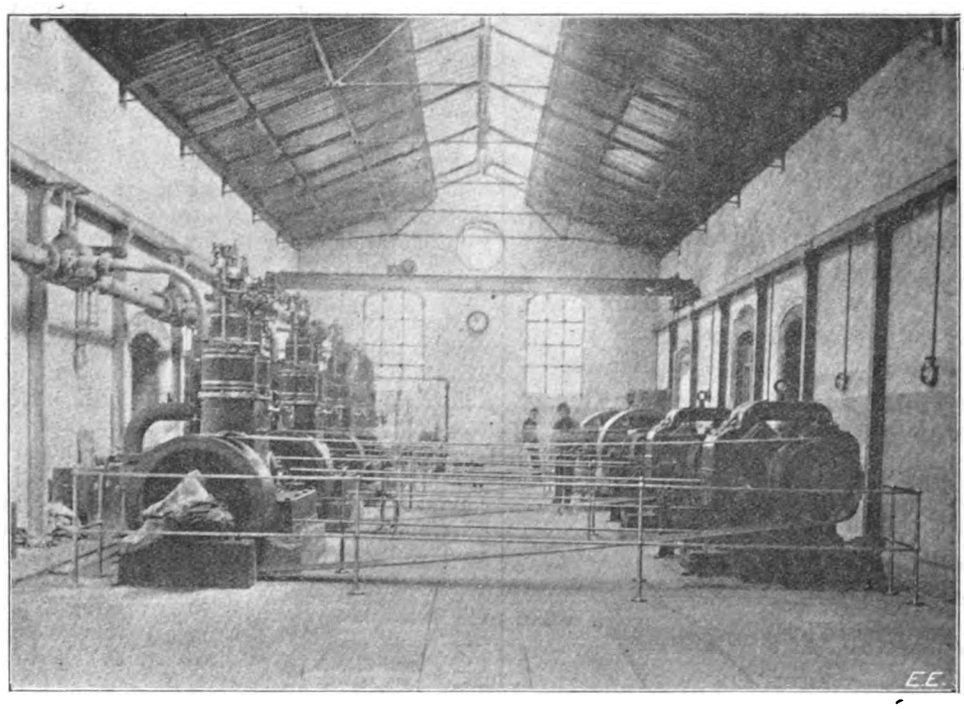

FIG. 18.—General View of Engine-Room.

SWITCHBOARDS.

The switchboard at the central station is not shown in any view, but it is not unlike that of the switchboard at the Blackrock sub-station, shown in Fig. 21. The diagram of the connections at Blackrock on this board (Fig. 22) will also help to make the arrangements clear. In this diagram A denotes a three-pole switch having a capacity of 50 amperes; B a rheostat of the F.F. 52 type for the motor fields, including a pilot lamp and the resistances required; C a small switch for use in connection with the lamps, for indicating phase difference; D a synchronising transformer having a transforming ratio of 25 to 1. At E are shown rheostats for the fields of the direct-current generators, while F is the starting rheostat for the same. G shows automatic railway cut-outs used to isolate the line in case of short-circuit; these are seen at the upper right-hand corner of the board (Fig. 21). H denotes a lightning arrester, and I a single-pole fuse. J J are high-tension alternating-current ammeters of the Nalder type, while K is a low-tension direct-current ammeter. V denotes a voltmeter, also for use with alternating currents, and N a Ferranti oil-break fuse, while synchronising lamps are indicated by the letter L. The alternators will usually be worked in parallel, but arrangements can be made for working them on individual lines, as there are two distinct triple concentric feeders between Ballsbridge and the Blackrock sub-station. The low-tension switchboard, shown in Fig. 20, needs no description; the small switches seen on it simply control the individual lighting circuits in the central station.

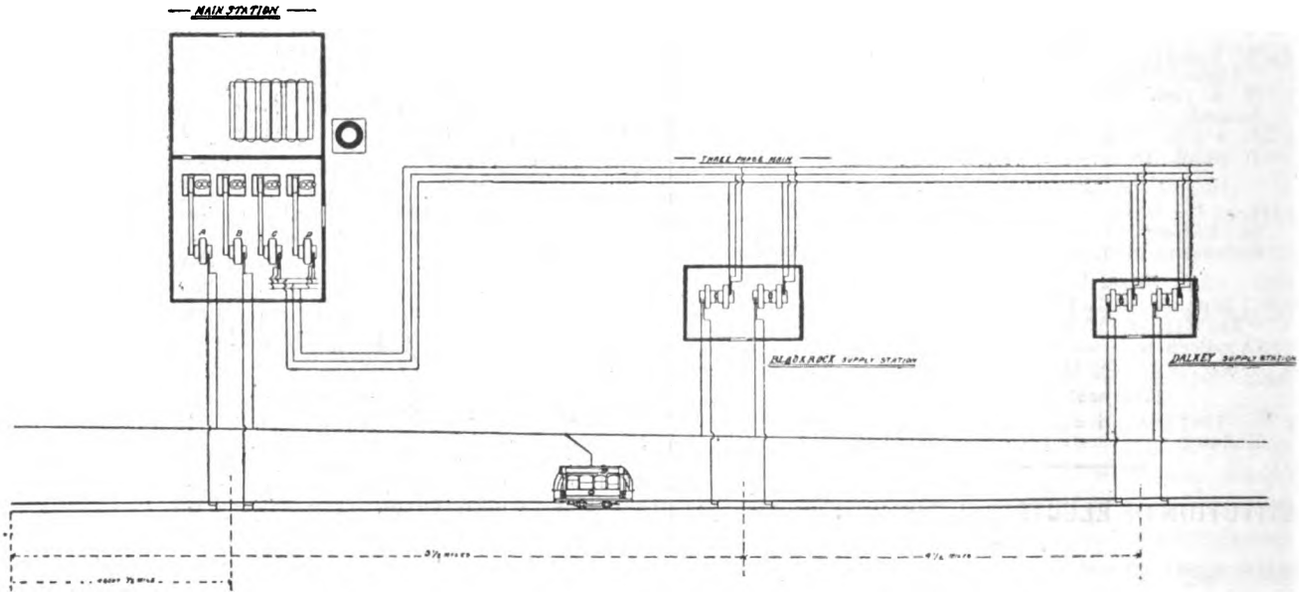

FIG. 19.—Diagram of the Connections of the Whole Line.

HIGH-TENSION FEEDERS.

The whole of the high-tension feeder mains were supplied by the British Insulated Wire Company (see Fig. 23). They are triple-concentric cables for tri-phase current, each

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conductor having a sectional area of ·05 square inch, and being insulated with their patent paper for working pressures up to 3,500 volts. They are lead-covered, and armoured over all. The total quantity of this cable supplied was 11½ miles, and the whole of it was tested length by length before leaving the factory with a pressure of 12,000 volts for 15 minutes both between the outer and inner and between the outer conductor and the earthed sheathing. Two of these cables are laid between Blackrock and Ballsbridge, and one between Blackrock and Dalkey. The cables are laid in a trench by the side of the footpath, and have been tested up to 5,000 volts in position.

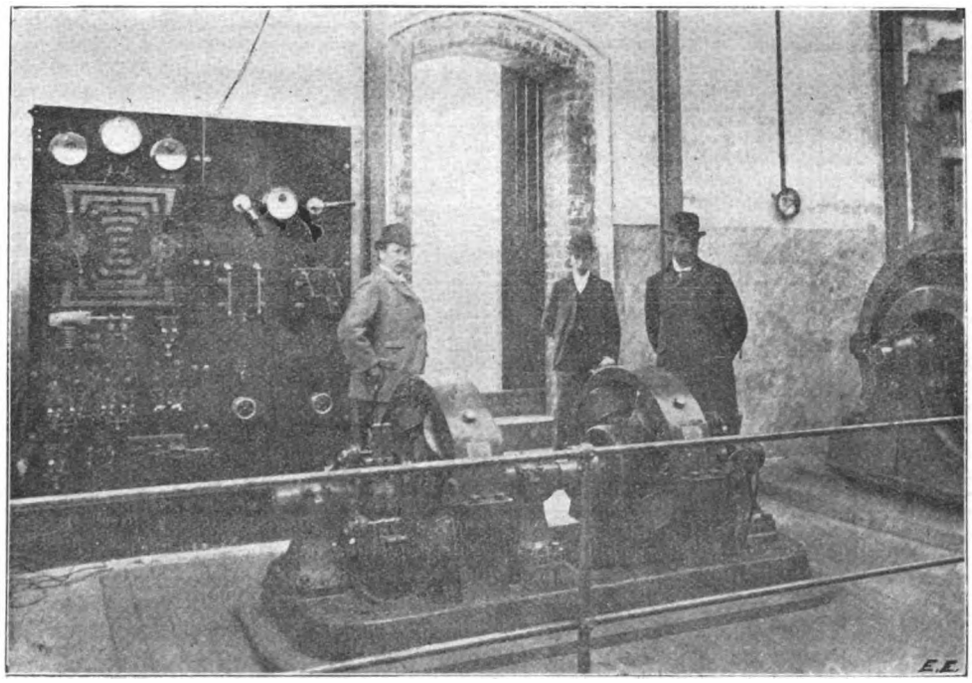

FIG. 20.—Direct-Current Transformer.

The direct-current generator is first connected on to the main 500-volt feeder and, by means of the starting resistance and field rheostat, is brought gradually up to its normal speed. The field of the alternating-current motor is then excited, and when the synchronising gear indicates that the correct phase has been attained the main switch is closed, which connects the motor to the high-tension feeder. The load can then be taken by the alternate-current machinery, and current supplied to the lines as required by the cars. The particulars of the switchboard at this station have been given above. At Dalkey a similar plant has been installed, except that the direct-

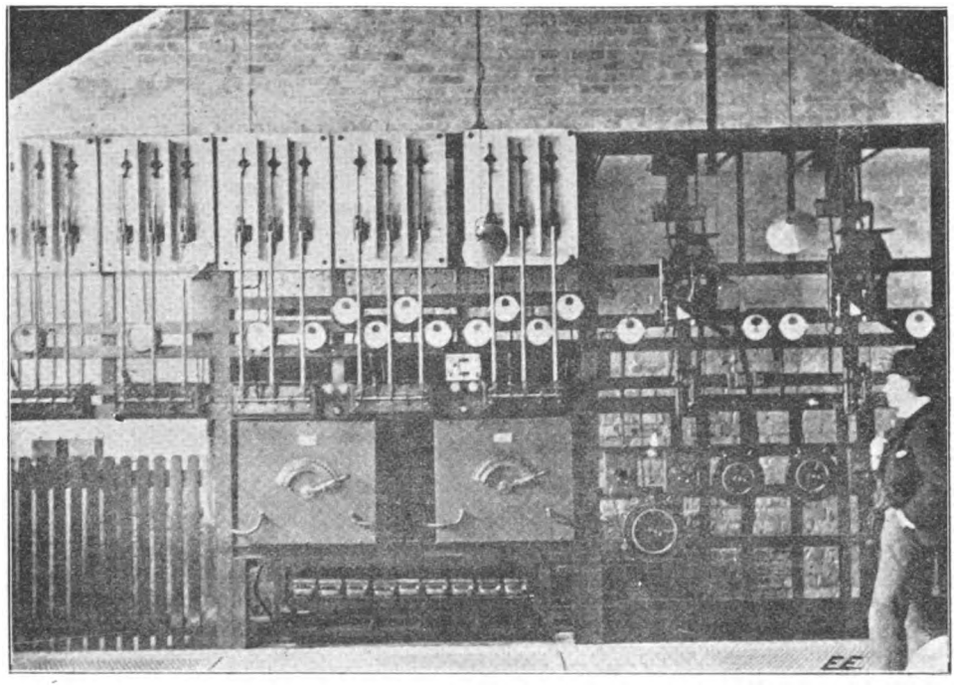

FIG. 21.—Switchboard at Blackrock.

SUB-STATIONS.

A full view of the above-mentioned station at Blackrock is shown in Fig. 24. The two transformers consist of two 60-kilowatt direct-current railway generators, coupled to two three-phase synchronous alternate-current motors working at 2,000 volts normally. The coupling between the two machines is effected by means of two pins projecting from one coupling, and fitting into holes in the other half, which are bushed with indiarubber. In this way any slight want of alignment is compensated for, and the machines have given no trouble in this respect. The method of starting one of these transformers is as follows:

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current generators are at present somewhat smaller. This arrangement is found to work most satisfactorily in practice.

Board of Trade Inspection.

The line was formally inspected by the Board of Trade on Thursday, May 7, and in spite of the stringent requirements of the Board as regards the conductivity of the return circuit, etc., everything was found satisfactory. A few alterations in the levels in the roads on either side of the track were ordered, and subject to these full permission for the opening of the line for regular traffic was promised.

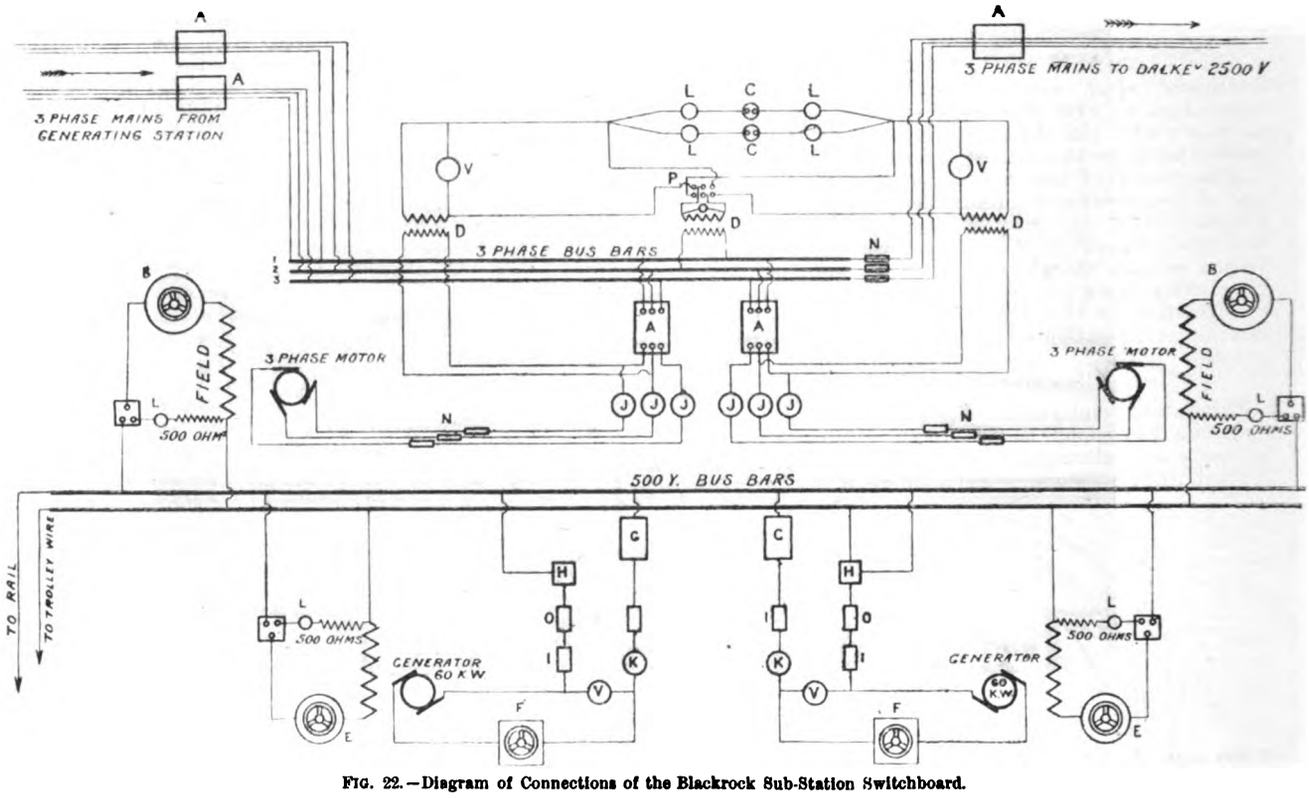

Fig. 22.—Diagram of Connections of the Blackrock Sub-Station Switchboard.

The company promised to do all they could to prevent any inconvenience.

We are able to give the above full particulars through the courtesy of Mr. Clifton Robinson and the British Thomson-Houston Company, as well as the various con-

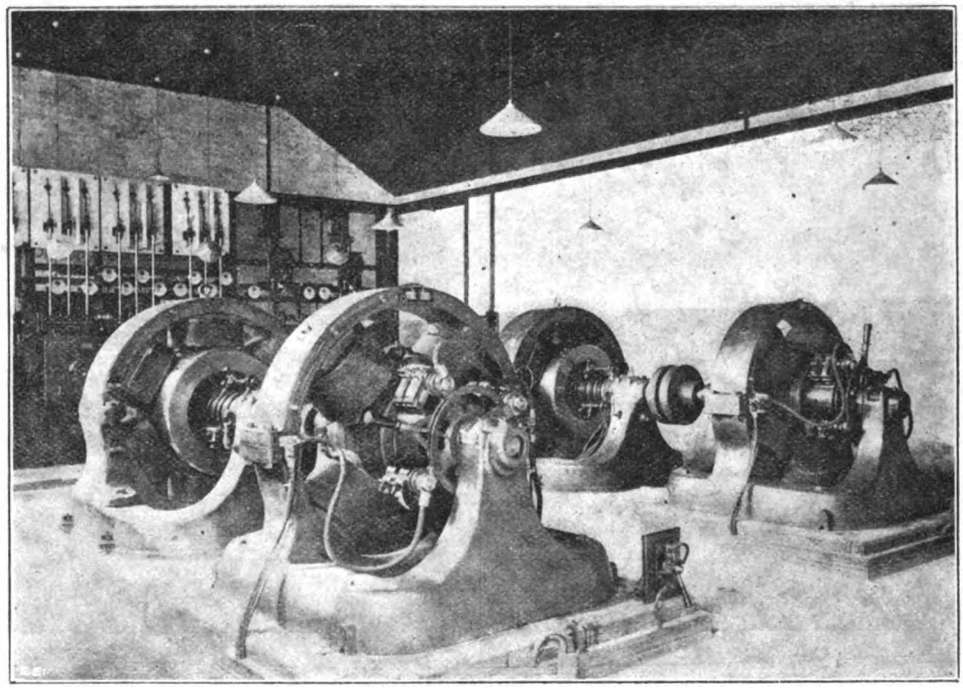

Fig. 24.—Blackrock Sub-Station, with Alternating-to-Direct-Current Transformers in the foreground.

Major Cardew made a careful inspection of the 16 miles of track, and found the electrical leakage to be only about one-sixth of the maximum allowed by the Board of Trade requirements. In George's-street, in Kingstown, several gentlemen boarded the car and formally complained that the double track would be an injury to their business, as it would interfere with the loading and unloading of their vans. The inspector said they had a right to be indignant with the Town Commissioners, but not with the company, who had obeyed the instructions given them by the local authority, which had involved an extra expenditure of £7,000.

We are able to give the above full particulars through the courtesy of Mr. Clifton Robinson and the British Thomson-Houston Company, as well as the various contractors who have had the work in hand. We wish Mr. Robinson every success in the running of this line, and trust that the excellent character of the work will assist him in obtaining the necessary powers for making the extensions into the heart of Dublin.

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EXPERIMENTAL TESTS ON THE INFLUENCE OF THE SHAPE OF THE APPLIED POTENTIAL DIFFERENCE WAVE ON THE IRON LOSSES OF TRANSFORMERS.*

BY STANLEY BEETON, C. PERCY TAYLOR (STUDENTS), AND JAMES MARK BARR.

Introductory.

At the conclusion of some articles on "Wave-Form Synthesis," which were published in June, 1895, we mentioned that we were then engaged in testing the iron losses in transformers with the aid of the method we had devised for easily altering the shape of the applied potential difference wave

This question of iron losses has naturally been regarded as one of considerable importance by electrical engineers, since the success of every system of alternate-current supply depends to a great extent on the all-day efficiency of transformers. Hence we have thought that an account of some fairly complete experiments on this subject might be worthy of the consideration of this Institution. These experiments were carried out at the Central Technical College during May, June, and July, 1895.

Description of Apparatus.

The method employed in our transformer tests was that of obtaining the complete curves of potential difference and current by means of an electrometer and Joubert contact-maker. This method, while being simple and accurate, is absolutely complete.

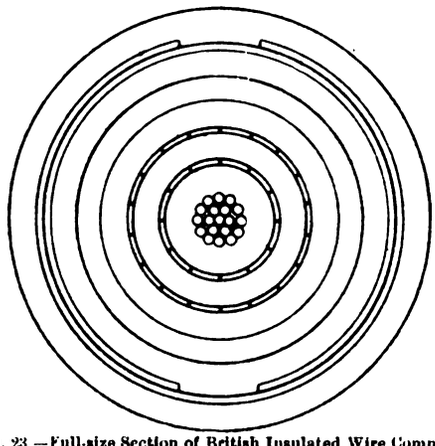

Fig. 23.—Full-size Section of British Insulated Wire Company's Triple Concentric Cable used at Dublin.

Any results required can be calculated from the two curves taken. The P.D. was kept constant by means of an Ayrton and Mather electrostatic voltmeter. Thus, we used only electrostatic instruments which required no sort of correction, such as is necessary when wattmeters and dynamometers are employed. The method we employed for varying the shape of the P.D. wave impressed on the transformer consisted in throwing into the circuit during similar parts of each half-wave a resistance or capacity by means of an apparatus which we have called the "injector." It is indicated in the accompanying diagram (Fig. 1), which also shows the details of the remainder of the apparatus used by us in testing the iron losses in the transformer.

The "Injector."—The arrangement which we have previously called the "injector" is shown diagrammatically at J. It consisted of two brushes, b_1 b_2, bearing on a commutator keyed to the shaft of the alternator. To these brushes was connected a resistance or capacity, as the case might be. We used a Ferranti alternator giving eight complete periods per revolution, and, in order that we could throw into the circuit any desired resistance or capacity during certain similar parts of each half-wave, the commutator was made with 16 segments. These segments—completely insulated from the machine and from one another—had no connections brought to them whatever; they were merely used to periodically short-circuit the two brushes, b_1 b_2. The position of the brush b_2 determined the epoch, or the instant at which the resistance or capacity was thrown into the circuit, while the distance between b_1 and b_2 determined the interval, or the duration of the effect for any given speed of the alternator. To the other end of the alternator shaft was fixed the usual form of Joubert rotating contact-maker. The movable brush, C, and fixed graduated scale, used for taking the wave-forms, were also employed by us to fix the positions of the "injector" brushes in the following manner:

Method of Setting the Injector Brushes.—The normal P.D. wave was first obtained in the ordinary manner, and by this means we really calibrated the fixed scale of the contact-maker; that is to say, we found positions of the brush C corresponding with certain points in the wave of P.D., thus imparting a definite meaning to each point in the scale. Having decided over which part of the normal P.D. wave the injection was to take place, we found the points corresponding with this interval on the fixed scale of the contact-maker. Let these points be a and d. The brush C was fixed with the pointer at a, and the alternator shaft turned until the metal web of the contact disc came under the brush (this is the position indicated in Fig. 1), and the trailing injector brush, b_2, was then adjusted till it was about to leave one of the segments. We next moved on the brush C to the point d and turned the shaft of the dynamo until contact between the brush and the metal web was again restored. With the armature in this position the brush b_1 was set so that it was just coming on to the next segment behind the one which b_2 had been adjusted to leave. It is evident, therefore, that during the interval in which the armature moves from the position a to the position d, the resistance or capacity inserted between b_1 and b_2 would be in the circuit, and that during the remainder of the half-wave it would be short-circuited.

Transformer Details.—Our tests were carried out on a Mordey transformer designed for an output of three kilowatts. The transformer was wound with three coils, two consisting each of 12 turns, and intended to be used with a pressure of 50 volts, while the third or fine-wire coil was wound for a pressure of 2,000 volts. This latter and one of the former were left on open circuit throughout these experiments, and the other coil was used by us as the magnetising coil, taking about three amperes at a frequency of 100 ∼. Hence, as the resistance of

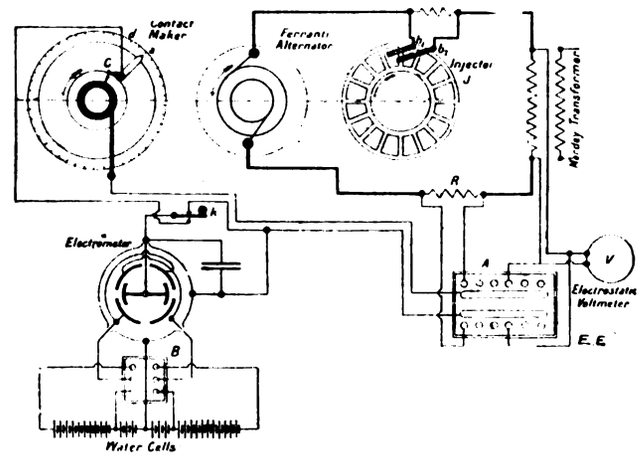

Fig. 1.

this coil was only 0·016 ohm, the drop in pressure due to it was negligible.

Electrometer Connections.—The instrument used for taking our waves was an Ayrton and Mather quarter-cylinder reflecting electrometer, connected up in series with the Joubert contact-maker. In parallel with the electrometer we had a small condenser, which was short-circuited by the key, K, after every reading. A number of water cells were used to maintain a permanent P.D. between the opposite pairs of quarter cylinders, and the P.D. to be measured was set up between the needle and the case. This method, as explained in our above-mentioned article, has the advantage of making the deflection directly proportional to the P.D. to be measured, even when the auxiliary P.D. required in the heterostatic use of an electrometer is quite small. The only readings used in working out the tests were those taken with the electrometer, for this instrument was also employed to measure the P.D. between the ends of a non-inductive resistance, R, placed in series with the transformer, and so to indirectly measure the current flowing through the latter. The electrometer was calibrated before, and in almost all cases after, every test with a set of 70 standard Clark cells. In order to facilitate taking the instantaneous values of both P.D. and current in quick succession, two change-over switches were used at A and B. A consisted of a solid block of paraffin wax, in which were cut two long slots and two rows of small holes, all of which were filled with mercury. The electrometer and contact-maker were directly connected with the two slots, while to the small holes were led wires from the terminals of the transformer and the non-inductive resistance, R, or from any points in the circuit between which we wished to find the instantaneous value of P.D. As a matter of fact, the terminals of the "injector" were also connected with a pair of holes in the change-over switch, A; but these wires are not shown in the diagram, as the graph obtainable at these points was not always taken, and it did not form an essential part of the transformer test. The value of the non-inductive resistance was 4·15 ohms, so that the maximum reading for obtaining the current-wave was about 16 volts, whereas the maximum ordinate of some of our P.D. curves was as high as

* Abstract of paper read before the Institution of Electrical Engineers, May 14.

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100 volts. In order, therefore, to use the full range of the electrometer in each case, it was necessary to change the potential to which the quarter-cylinders were charged; hence for the P.D. wave we used six cells between the opposite pairs of quarter-cylinders, and for the current-wave 30 cells, the middle of either set being connected with the case. This alteration was effected by means of the change-over switch, B. An Ayrton and Mather electrostatic voltmeter, V, was used to keep the R.M.S. volts at the terminals of the transformer constant during each test.

Speed of the Alternator.—The speed of the alternator, which could be adjusted by means of coned pulleys, was kept constant at 750 revolutions per minute, thus giving a frequency of 100 ⌣⌢. No electrometer reading was taken unless the speed, as shown by a Rungs pneumatic speed indicator, was exactly right. The indicator was checked several times by a revolution counter and found perfectly accurate.

Advantages of Open Secondary Tests.—Since it is now generally admitted that, with the exception of a slight drop due to leakage at high loads, the total iron losses in a transformer are constant at all loads for the same frequency, we made all our tests with open secondary circuit. This method of attacking the subject offers great advantages, because errors caused by the variations of temperature in the iron core and the non-inductive resistance, R, due to the use of different currents, are not introduced into our experiments. In addition to this, it will be seen that the working out of our results is somewhat simplified, especially with respect to the determination of the maximum induction. It is in the determination of the iron loss, however, that the method possesses its chief advantages, for we can measure this loss directly, and not as the difference of two much larger quantities. By this means we have been able to find the iron loss accurately to within ½ per cent., which would have been quite impossible with a load on the secondary.

Discussion of Curves.

All the curves of P.D. and current given in the figures have been obtained by taking the means of the homologous readings on each half-wave. The mean wave thus determined was never found to differ appreciably in any way from the positive or negative half-wave. Each wave was drawn as the observations were made, so that, when the exact contour of the wave appeared doubtful, more readings at points intermediate between those already observed could be at once taken and plotted; hence a large number of observations were made on every wave, sometimes as many as 48 points being taken. The normal P.D. wave of the Ferranti alternator (Fig. 2) is seen to be very nearly a sine curve, while the current-wave possesses the characteristic deformation always observed when a transformer is working light.

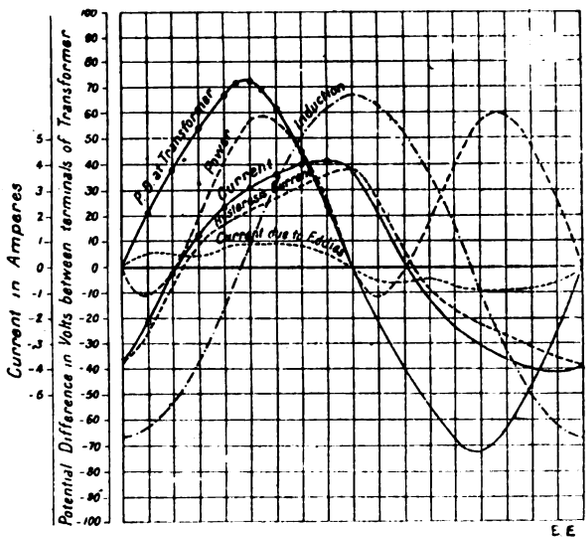

Fig. 2.

Induction Waves.—The induction wave must be found by integrating the curve of back E.M.F. Now in our case the latter is practically identical with the applied P.D. wave, since the drop in pressure due to the resistance of the magnetising coil is negligible. It is interesting to note how smooth the outlines of the induction curves are, even when derived from very distorted waves of potential difference. We have, therefore, to integrate the P.D. wave; but to do this we require some starting point, and this must first be found. When the ordinate which divides the half-wave of P.D. into two parts of equal area is known, this presents no difficulty, as the induction must be zero at the point where this ordinate cuts the axis of time. When, however, as is more often the case, we do not know this ordinate, then the above relation will not help us; but there is another relation which is true in every case—viz., that the induction must be a maximum when the P.D. is zero. It is evident, on reference to Fig. 3, that, according to this relation, the induction must pass from a negative to a positive maximum, or *vice versâ*, during the half period of the P.D. wave. Since the induction wave is the integral of the P.D. curve, it will also be evident from Fig. 3 that the area of the semi-wave of P.D., multiplied by the required constant, will give twice the maximum induction. (This constant must contain the number of turns in the magnetising coil and the cross-section of the iron core.) Thus in every case we can get a starting point for the induction curve by setting up the maximum induction at the point where the P.D. is zero.

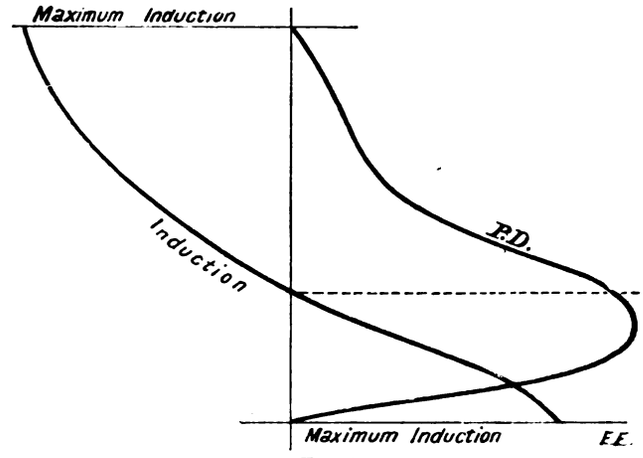

Fig. 3.

The wave is then drawn by integrating the P.D. curve in steps from this point, and subtracting the inductions thus obtained from the maximum value. This direct relation between the maximum induction and the area of the P.D. wave is of the greatest importance, for it is evident then that the amount of hysteresis loss for different shapes of applied P.D. waves will depend only on the areas of these waves.

(To be continued.)

THE ELECTRIC LIGHTING OF SURBITON.

The District Council have recently printed and circulated the report of Dr. Hopkinson on the tenders they had received for laying down an electrical installation. After comparing the conditions of Surbiton with those of Whitehaven, Dr. Hopkinson proceeds to discuss the relative merits of the high and low tension systems of electrical distribution, and concludes: In the case of Surbiton the maximum distance to which you would have to go is less than a mile, and I should therefore have not the least hesitation in recommending the direct-current low-tension system with a maximum difference of pressure of 400 volts or thereabouts, giving 200 volts on the lamps, and that the streets throughout the district, with the exception of, perhaps, of some of the new extreme outlying parts, be lighted from the same source of supply as the private lights. The street-lighting circuits should be all taken in to the generating station independently of those for private lighting, as in this way a considerable economy will be effected, owing to the facility with which the lights can be lighted and extinguished. The number of street lights to which a supply of current would have to be carried would be about 480, and of these a considerable number have at the present time multiple burners of considerable power. To replace the whole of these lights with incandescent lights of somewhat greater power would require about 60 i.h.p. But it is probable that a larger number of lights of increased power might at a future time be required, and I should therefore provide engines and dynamos of 100 i.h.p. each, and use the excess of current generated (if any) for the purpose of aiding in the charging of the accumulators.

Surbiton is fortunate in having a vacant space right in the centre of the district suitable for the generating station. This is upon the land to the south side of the railway, and slightly to the west of the railway station.

The equipment of the generating station would be as follows: four Babcock and Wilcox boilers, each capable of generating steam for 100 i h.p.; an economiser; four sets of Willans engines (with dynamos), each capable of indicating 100 h.p.; Ledwards evaporative condensers; the suitable switches and instruments, and a battery of equal power to about one of the dynamos. Each engine would be competent to supply current for 1,000 incandescent lamps of 16 c.p. each, so that if one engine be considered as spare, you would have, including the battery, a plant capable of supplying 4 000 lights.

We will now consider the capital outlay which the provision of this plant and the conductors will involve. This is shown on the accompanying Schedule I., in which it will be seen that the total cost amounts to £22 000, which involves an annual charge for interest and sinking fund of about £1,200, which would have to be paid whether there were private consumers or no. The actual

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cost of running the station would, of course, depend in part upon the amount of current to be generated. Assuming that the maximum demand in the evening was sufficient to occupy three engines, three boilers, and the accumulators, I should estimate that the whole running charges would be less than £1,800, making the annual outgoings less than £3,000 Consider now the other side. You have to begin with about £1,800, the present cost of street-lighting with gas. This would be replaced by better lighting which we assume is done at the same cost by electricity. You have available power to light in addition to this 3,000 16 c.p. to 3,500 16-c.p. incandescent lamps on private consumers' premises. This would imply that a considerably larger number were wired. General experience has also shown that a 16-c.p. lamp will bring in a revenue of from 15s. to 20s., so that if the plant were completely occupied at full rates of charges a revenue of at least £4,500 might be anticipated from private consumers. Against this will of course have to be set the charges for service mains and meters, which would increase the capital outlay and consequent charges for interest and sinking fund to a small extent. This will serve to show that in the event of the light being largely taken up by private consumers, the possible profit to the Council would be considerable. Probably, however, a less number of lamps and a lower return per lamp might be expected, but the demand would be poor indeed if £1,200 a year could not be speedily secured from private customers, and it must further be remembered that if the demand for current were diminished, the cost of running would also be diminished.

It will be more convenient to consider the matter from another point of view. After crediting the account with the present cost of lighting the streets by gas, there would remain less than £1 200 per annum to be met by the receipts from private consumers. How many lamps would it be necessary to instal to secure such a revenue? At 15s per lamp, 1,600 would suffice. This number is less than you may with confidence anticipate. The fact of there being at once a very large consumer in the public lighting ensures that in the case of Surbiton the undertaking should be commercially successful from the very commencement.

Let us, however, consider what the cost of lighting the streets without the addition of any private lighting would be. Schedule II. shows an estimate of ample power, ample buildings, and ample conductors for the supply of the 480 lights in the town, with a margin for additional lights and a spare engine and boiler. No accumulators are required, as the light need not be supplied in the daytime. The total capital cost is about £9,200, entailing a charge for interest and sinking fund of £506 per annum, leaving £1,300 for the cost of running the plant and repairs, a sum materially in excess of anything which would be at all possible.

The final conclusion at which I arrive is that it would pay the Urban Council to do the lighting of the whole of the street lights of the town, even if there were no additional lighting required and, further, that by so doing they would place themselves in a position to do the private lighting on any scale it might be desired at a moderate cost and with a profit to the rates.

Dr. Hopkinson proceeded to make a comparison of the illuminating power and the cost of gas and electricity. giving electricity at 8d. per unit as equivalent to gas at 5s. 4d., and electricity at 6d. per unit equal to gas at 4s.; and considering the great advantages of electric lighting in regard to health, to saving of decorations and to convenience for decorative purposes, says there is no doubt it is worth while to use it at even a substantially greater price than gas.

Coming to the series of tenders placed in his hand for consideration and report, we find five out of six are for the alternating-current system disapproved by Dr. Hopkinson; they are those of Messrs. John Fowler and Co., the Brush Electrical Engineering Company, Messrs. Crompton and Co., Messrs Siemens Bros., and the Capital and Counties Company. The only low-tension tender is that of Messrs. Sharpe and Kent, which Dr. Hopkinson regards as inadequate. He says: None of these propose to light the whole of the streets in the district, and this could undoubtedly be done with profit with the exception of a few outlying lamps, which it would be better to leave to the present source of supply, although they could easily be lighted electrically if no other method were available. Further, with the exception of Messrs. Sharpe and Kent's tender, they would all in my judgment be financially at a disadvantage, owing to their adopting the alternating-current system in a district where the distances are short and consequently requiring machinery to be running during the day time.

It may perhaps be convenient to state here that if arc lighting was desired in the streets there would be no difficulty whatever in providing it from the current system proposed for the lighting by incandescent lamps.

On the whole I am clearly of opinion that a reasonably bold policy is the most prudent one. You are sure of a good customer in yourselves for the street-lighting, which will at once place you in the position of being able to supply private lighting at such a moderate cost as will secure its adoption to a considerable extent.

Appended to the report are a couple of schedules, containing estimates (1) for lighting streets and for private lighting, (2) for lighting streets only. The details are—Schedule I.: boilers £1,528, feed-pumps £120, economisers £180, steam and waste pipes £400, four Willans engines (100 h p) and four dynamos (125 amperes at 480 volts) and one spare armature £3,076, condensers, etc., £435, accumulators £885, switchboards, etc., £680, conductors (mains) for private lighting £6,998, ditto for 480 street lamps and altering street standards £3,578, buildings (exclusive of site) £2,000, contingencies £1,988—total £12,868. Schedule II. shows an alternative estimate for street-lighting only, the total of which is £9,161, also apparently exclusive of site.

LEGAL INTELLIGENCE.

THE REGISTRATION OF DESIGNS.

In the Court of Appeal on Monday last, before Lords Justices Lindley, Lopes, and Kay, judgment was given in the case in *re* Clarke's Registered Design No. 206,870.

This was an appeal against the refusal of Mr. Justice North to order a design for a lamp for electric lighting, which had been registered under the Patents, Designs, and Trade Marks Acts by Mr. John Farrand Clarke, to be taken off the register, on the ground that the design was not new or original. The official certificate of registration given by the Comptroller stated that the design No 206,870 "was on February 1, 1893, registered in Class I., in the name of John Farrand Clarke, and that a copyright of five years was granted; also, that the claim under 'Statement of nature of design' is as follows: 'Lamp for electric lighting, application for its shape.'" The lamp is intended for use outside shop windows, so as to throw light upon the windows and the articles displayed therein The application to expunge the registration was made by Messrs. Julius Sax and Co, Limited.

Mr. Vernon Smith, Q.C., and Mr. Charles Church were for the appellants; Mr. Swinfen Eady, Q.C, and Mr. K. G Metcalfe were for the respondent.

Elaborate judgments were read by each of their **Lordships**, all three concurring that the appeal must be allowed.

Lord Justice Lindley said the design being on the register it was for those who disputed the propriety of its registration to show that at the date of registration this design was not new or original, and was well known in the United Kingdom The question is whether this is proved. His lordship held that it was. On the question of what constituted "novelty" in a case of this kind his lordship remarked that the design must be new or original with reference to the kind of article for which it was registered. A design might be new for a coal-scuttle, but not for a bonnet. On the other hand, a design for a shade of a gas lamp could hardly be new if it was old for an oil lamp. In the present case the design registered was for the shade for an electric light. If when registered the design was not new or original for all lamps, if the shape was common for such lamps as were used before electric lighting was invented, the design was one to which the Act did not apply, and the design ought to be expunged. Electric lighting being new, every lamp or lamp-shade adapted to it for the first time might be said to be new or original if attention was paid only to its application to the new method of lighting. But it was absurd to suppose that the application of an old-shaped lamp or shade to an electric light could be protected under this Act. There must be some novelty or originality in the shape as applied to sources of light in order that a design for the shape of a lamp can be protected. In this case the design registered was nothing more or less than an old and well-known lamp or lamp-shade, with the omission of a part which was wanted for gas or oil burners, but which is useless for an electric light. The old shape of lamp or lamp-shade consisted (1) of a reflecting screen of the same shape as the reflecting screen in the registered design; (2) of a ventilating top differing in no substantial particular from the ventilating top in the registered design; (3) of a chimney on the ventilating top, and which chimney is omitted from the registered design, not being wanted. The omission of the chimney rendered it necessary to cover in the ventilating top, but that did not really alter the shape of the lamp or lamp-shade. Mr. Clarke had adapted a well-known lamp or lamp-shade to electric lighting but the shape was the old shape, with the omission of a useless appendage. No doubt a combination of old shapes might result in a new or original design for shape; and if that is the result that design would be protected if registered under the Act. But when, as here, the old shape of an article well known in the United Kingdom consisted of three shapes of three parts placed one over the other, and the new shape was exactly like the old shape, except that unless the useless upper part was omitted, it could not be said that the shape of what is left was new or original or that the residuary shape had not been previously published.

The judgments of **Lord Justice Lopes** and **Kay** were to the same effect, and the appeal was allowed, with costs, and an order made to remove the design from the register.

COMPANIES' MEETINGS AND REPORTS.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

A meeting of this Company was held on Wednesday at Winchester House, Lord Sackville Cecil presiding.

After expressing great regret at the absence from the chair of Sir John Pender, and sympathising with him and his family on account of his long and dangerous illness, the **Chairman** said the present was an interim meeting, and it was not opportune to discuss large and important questions of policy. In moving the adoption of the report (an abstract of which has been given in these columns), Lord Sackville Cecil remarked that the falling off in receipts had arisen on the east side of South America—namely, the seaboard of Brazil, Uruguay, and Argentina; and was

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sufficiently accounted for by the fact that for four months of the half-year the charges from that side of the Atlantic were reduced by 70 centimes, or nearly 7d. a word. On the question of compensation for low rates which might be derivable from the consequent increased volume of traffic, he remarked that it was a subject upon which there was still a great deal of misconception outside the small circle of those who were immediately engaged in the conduct of telegraph business. It was greatly to be wished that all who approached this subject should appreciate that there was not much real analogy between the results to be anticipated from lowering postages or carrying rates of commodities and those of lowering telegraph rates, and any inferences drawn from analogy between them required most careful scrutiny. When a cable was once full another had to be laid, at large initial expense, and it had to be manned and maintained in addition to what already existed. Therefore, after a certain turning point—which in telegraphy might soon be reached—they had, besides the additional working expenses, to contemplate interest on freshly-sunk capital. These considerations led up to the question of the best appliances for getting the maximum duty out of lines already laid, and the Board had lately entered into an agreement whereby they would obtain the use of quite the most modern automatic appliances for signalling through long cables. The Board were preparing generally for the unpleasant prospect of having to do the increase of the Company's work at less profit, and he looked for some addition to their working expenses in the future. The Amazon telegraph extension to Manaos would act as a feeder, and would, they hoped, settle down into a successful undertaking. With their allies, the Eastern Telegraph Company, and with the Telegraph Construction and Maintenance Company they had also joined in a new concern called the German Telegraph Company, having for its object the laying of a cable from Emden, in Germany, to Vigo, in Spain, whence there was a short cable to Lisbon, where their own main cable diverged. The new line was in course of construction, and if their hopes were realised it should carry a valuable North European traffic for their route, much of which was now lost to them.

Mr. Frederick Youle seconded the adoption of the report, and it was carried unanimously.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held yesterday at Winchester House, the chairman, Mr. W. S. Andrews, presiding.

The **Chairman**, in moving the adoption of the report and accounts, which were taken as read, said their takings had been £80,315, as compared with £82,815 for the corresponding period, showing a reduction of £2,500. The amount of business transacted had been larger, but the falling off in receipts was due to the losses which had been sustained in exchange and to the reduction in the tariff that had been made from time to time. They and the Platino Company showed an ingathering of £40,000 less than they would have done at the par of exchange. He thought the current half-year was likely to turn out less favourable, unless the rate of exchange improved. He proposed that a dividend of 5s. 3d. per share be declared, which, with the interim dividend already paid, was at the rate of £3 per cent.

Mr. Earle seconded, and the motion was carried.

The retiring directors and auditors were re-elected, and a vote of thanks was passed to the chairman, the Board of Directors, and to the managing staff.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Hamburg.—The Finanz Deputation want tenders for a crane for the electricity works by 26th inst.

The Hague.—The Dutch Colonial Office wants tenders by 27th inst. for the supply of galvanised iron wire for the telegraphic service.

Prague (Austria).—Tenders are wanted by June 1 for an electric lighting central station for the city of Prague. Application should be made to the Stadtrath, Prague.

Penaranda de Bracamonte.—Tenders for electric lighting of the town for a period of 15 years may be sent to the authorities at the Casa Consistoria, Peneranda de Bracamonte, Spain, by May 28.

Berlin.—Tenders are wanted by May 22 by the State Railway Direction for about 15 tons of copper in sheets, and about half a ton of brass wire. Particulars at the Rechnungsbureau, Berlin W, Schöneberger Ufer 1.

Coblentz.—Tenders are wanted by 30th inst. for the annual supply of 10,000 to 13,000 wooden telegraph poles for four years. Particulars from the offices of the Konigl. Ober-Postdirection, Coblentz, for 30pfg. (3d.).

Giessen (Germany).—Tenders will be received by the Administration of the Hessian Grand Ducal Railways up to 21st inst. for lightning conductors at four stations on Grünberg and Loudorf line. Particulars for 1·8 marks (1s. 10d.) at Giessen, Frankfurterstrasse 64.

Lisbon.—The Royal Portuguese Railway Company will receive tenders up to June 3 for the supply of small telegraphic stores. Application to the Chief Engineer, Stores Department, Santa Apolonia Station, Lisbon, and particulars also obtainable at 28, Rue de Châteaudun, Paris.

Paris.—Tenders will be received by the Prefect of the Seine at the Paris Tribunal de Commerce on May 23 for the installation and working for 10 years of the electric light at the Hospice de Brévannes. The estimate is about £5,533, and the maximum annual payment 27,600f. (about £1,080).

Gisburn.—Tenders are invited for the various works required in erection of new buildings for electric lighting plant and homestead purposes at The Woodlands, near Gisburn, for Chas. J. Massey, Esq., J.P. Quantities may be obtained on application to Mr. Charles Parsons, architect, 9, Grimshaw-street, Burnley.

Bray (Ireland).—The Town Council want tenders by May 17 for (1) a steam alternator, 75 kilowatts; (2) a Lancashire boiler 200 h.p.; (3) economiser and feed-pump; (4) a vertical high-speed engine. Specifications, etc., can be obtained from Mr. P. MacDonnell, town clerk's office, Town Hall, Bray, on deposit of two guineas.

India Office, S.W.—The Secretary of State for India in Council is prepared to receive tenders to supply (1) spans, (2) iron telegraph posts. The conditions of contract may be obtained on application to the Director-General of Stores, India Office, Whitehall, S.W., and tenders are to be delivered at that office by 2 p.m. on 19th inst.

Burton-upon-Trent.—The Council require tenders for the supply of 25,000 tons, or a portion thereof, of best screened gas coal. Forms of tenders and conditions of supply may be obtained upon application to Mr. F. L. Ramsden, manager and engineer Gas and Electric Light Works, Wetmore-road, Burton-upon-Trent; and sealed tenders, endorsed "Coal," are to be delivered to the manager at or before 10 a.m. on 27th inst.

Bucharest.—Tenders are wanted by the Municipal Administration of Bucharest by June 24 for a concession for lighting the city for a period of five years. A security of 15,000 lei (about £600) will be required. The Municipal Authorities of Bucharest ask for further tenders up to June 24 for lighting the suburbs and environs "on a system without (underground) pipes more suitable than those that have been already offered." It is desired to replace 3 265 petroleum lamps, and the contract will be for five years. Communications should be sent to the Mairie at Bucharest.

Hammersmith (London).—The Vestry want tenders for the following: (*a*) the supplying and laying of high-pressure and low-pressure cables and pipes; (*b*) the supply and erection of arc lamps and lamp-posts; (*c*) the supply and erection of transformers and sub-station equipment; (*d*) the supply and erection of a five-ton overhead travelling crane. Specifications, general condition, and form of tender can be obtained at the office of Mr. A. H. Preece, 39 Victoria-street, Westminster. Applications for any one or all of the above sections must be accompanied by a cheque for £2. 2s. which will be refunded on receipt of a bona fide tender. Sealed tenders, endorsed "Cables," "Arc Lamps," "Transformers," or "Crane," must be delivered at the offices of the Vestry, 57, Fulham Palace road, Hammersmith, by noon on 27th inst. Mr. W. P. Cockburn, vestry clerk.

RESULTS OF TENDERS.

Morley.—The Town Council have accepted the tender of Messrs. Graham, Chapman, and Co. to fix the electric light to the stage fittings at the town hall for £44. 12s.

Bradford.—The Town Council have accepted the tender of Messrs. J. Moulson and Sons for the construction of a reservoir and tank at the new electricity works, Valley-road, for the sum of £890, Messrs. Broxup and Sons having declined to proceed with the contract.

London.—The Metropolitan Asylums Board have accepted the tender of Messrs. Cox-Walker's for the provision of telephones, electric bells, and fire alarms for the Brook Hospital and Ambulance Station, in accordance with drawings and specifications prepared by Prof. A. B. W. Kennedy, at the sum of £658. 7s. 6d. The following is a list of the other tenders received:

Brown and May, Limited, Devizes	£534	19	0
Pearson's Automatic Fire Indicator Company, Limited, Westminster	572	16	0
L. Alwyn, Queen Victoria-street	662	0	0
Tabor and Hinchcliffe, Cambridge	706	0	0
Mason, Wathes, and Brown, Leicester	722	18	6
Consolidated Telephone Construction and Manufacturing Company, Limited, Shaftesbury-avenue	784	16	5
Private Wire and Telephone Installation Company, Cannon-street	1,009	5	10
Vaughan and Brown, Limited, Kirby-street, E.C.	1,010	0	0
W. J. Furse, Nottingham	1,024	2	3
Strode and Co., Regent's Park	1,433	0	0
W. Seymour, Chelsea	1,500	0	6
Julius Sax and Co., Limited, Ridgmount-street, W.C.	1,657	2	0
C. E. Zimdars, Gray's-inn-road	1,900	0	0
National Telephone Company, Limited, Marshalsea-road, S.E.	2,032	0	0
Single Wire Multiple Telephone Signal Company, Limited, Old Broad-street, E.C.	2,244	0	0

Hampstead.—The Vestry have accepted the tender of Messrs. S. Z. de Ferranti, Limited, for the steam alternator and switchboard, at the price of £3,397. They have also accepted the tenders of the Brush Electrical Engineering Company for the tank and

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appurtenances at £408. 10s., and the feed-water heater and steam pipes at £942.

Brighton.—The following tenders were received for the preparation, supply, and delivery at Brighton of cast iron and drawn-steel bracket posts for suspending electric light arc lamps, for the Corporation :

Reed and Son, Brighton (accepted)	£2,460
Hart, Son, Peard, and Co., Limited, Birmingham	2,500
Mackenzie Bros., Edinburgh	2,500
Manlove, Alliott, and Co., Limited, Nottingham	2,605
Lloyd and Co., Abercarn	2,800
Macfarlane and Co., Glasgow	3,060
Newton, Chambers, and Co., Limited, Sheffield	3,840

BUSINESS NOTES.

Wells.—The Town Council have decided not to instal the electric light.

London.—The church of Allhallows-on-the-Wall is to be lighted by electricity.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,580.

Blackburn.—The Town Council are about to apply for leave to borrow £10,000 for electric light extensions.

Grimsby.—The Lighting Committee have decided to purchase a new dynamo for the town hall at a cost of £144. 10s., capable of 110 volts.

Exeter.—The Electric Lighting Committee propose to give a day as well as a night service, and have offered special terms to the hospital.

The South Staffordshire Tramways.—The Board of Trade have sanctioned the use of steam on these tramways for a further period until March 25 next.

St. Helens.—Mr. Samuel Glover, the gas manager, is to have the superintendence of the new electrical works, but he will have an electrical engineer under him.

Armagh.—The governors of the county asylum have decided to light the new hospital with electricity, and have appointed a committee to go into the question.

Hong-Kong.—The business of the electric light company of Hong-Kong is extending so rapidly that the question of providing additional plant is under consideration.

Dover.—The Corporation have received official sanction to their scheme of electric tramways, and the work will be proceeded with immediately at an estimated cost of £50,000.

Paisley.—The Town Council have decided to delay deciding whether a resident or a consulting engineer should be appointed in connection with the proposed electric lighting.

Great Horton.—At the half-yearly meeting of the Industrial Society, a proposal of the directors that an electric light installation be fitted up at the central stores was agreed to.

Sunderland.—The Avenue Theatre will shortly be lighted throughout by electricity, and a special feature will be made of the electric lighting during the forthcoming pantomime.

New Company.—The British Horseless Carriage and Motor Cycle Company, Limited, has been registered by Lumley and Lumley, 37, Conduit-street, W., with a capital of £10,000 in £1 shares.

Clapham (Yorks).—This village is now lighted by electricity, which was switched on last week for the first time. There are over 1,000 yards of cable, and in the streets 10 32-c.p. lamps have been placed.

Chelsea Electricity Supply Company, Limited.—Letters of allotment and regret for the issue of 12,000 ordinary shares were posted on Tuesday. The issue was, we are informed, considerably over-subscribed.

Sheffield.—The House of Commons Committee have passed the preamble of the Corporation's Tramway Bill and authorised the purchase of the tramway company's plant at the expiration of their lease in July.

Torquay.—The Town Council have received a letter from the Local Government Board stating that one of their inspectors would hold an enquiry concerning the proposed electric lighting installation as soon as possible.

The Jandus Arc Lamp.—We have received from Messrs. Drake and Gorham printed copies of testimonials received from a large number of firms as to the Jandus lamp. The lamp has been fully described in our columns.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending May 10 amounted to £1,162, as compared with £1,159 in the corresponding week of the previous year, being an increase of £3.

Kidderminster.—The gas company have endeavoured to obtain a *locus standi* with reference to the Bill for the Kidderminster and Stourport electric tramway, on the ground that their mains might be effected and explosions occur.

Bexhill.—At the meeting of the Urban District Council, the Clerk said he had received plans and notice of the application made by Earl De La Warr to supply electric light to Bexhill. The matter was referred to the Highways Committee.

Bradford.—The Town Council have approved a plan showing a proposed rearrangement of gas and tar pipes and condensing and scrubbing plant at Thornton-road Gasworks, and have instructed the engineer to carry out the work at an estimated cost of £1,400.

Islington (London).—At the meeting of the Vestry the clerk read a communication from the principal officers of the Vestry, including Mr. Gay (electrical engineer), asking for permission to accept articled pupils. The matter was referred to the General Purposes Committee.

Bury St. Edmunds.—The report of the Electric Lighting Committee, as to which there have been various rumours, will not be delivered until next month. So far as the report is concerned, it is believed that the matter in question is really the amount of the area to be undertaken.

Cheltenham.—Mr. Norman, in submitting the minutes of the Electric Lighting Committee at the meeting of the Town Council, mentioned that a tasteful pattern of standards for electric arc lamps had been approved, and that in all 6,600 lamps had now been wired. The minutes were approved.

Hull.—At the meeting of the Town Council a vote of thanks was passed, on the motion of Alderman Fraser, seconded by Alderman Massey, and supported by Alderman Seaton, to Councillor Holder for his services to the town in his capacity as chairman of the Electric Lighting Committee.

Glasgow.—The electrical engineer of the Corporation is preparing a specification for the electric lighting of the Ruchill plant. The Tramways Committee will, it is understood, recommend to the Corporation the adoption of the overhead electric system, with provision for seats on the top of the cars.

Acton.—At the meeting of the District Council a letter was read from Mr. Goddard on behalf of Mr. Cohen with reference to the electric lighting. The Chairman reminded the Council that Mr. Goddard had been asked to put any propositions he might have to make. The letter asked the Council to purchase for £2,600.

Killarney.—At the meeting of the Town Commissioners the clerk produced a legal document, served at the instance of Messrs. Huggard and Willington on him, in the matter of the auditors' surcharges for money amounting to £85 paid the Killarney Electric Lighting Company for public lighting, which is now in the Court of Queen's Bench.

City and South London Railway.—The returns for the week ended May 10 were £909, compared with £832 for the corresponding period of last year, being an increase of £77. The total receipts for the half-year terminating as above were £17,936, compared with £17,815 in the same period of the preceding year, being an increase of £121.

Calcutta.—It is stated that three firms in Calcutta have taken up the matter of the supply of electricity in the city. It is hoped that the tramway company will substitute electrical for animal power to propel their cars. It is obvious that in a city like Calcutta there are greater difficulties in the way of animal traction than in a cooler climate.

Tamworth.—At the meeting of the Town Council a letter was read from the Postmaster General to the effect that he considered the electric fire-alarm from the workhouse to the fire brigade station an infringement of his exclusive telegraph rights, but would allow it to remain on payment of the nominal fee of 1s. per annum, which was agreed to.

Folkestone.—At the meeting of the Town Council a long discussion took place on the electric light question with regard to the disposal of the provisional order, but it was eventually decided to postpone the matter for a fortnight. The Electricity Bill has passed through the House of Commons and is now in the Lords. It is likely to become law at an early date.

Chelmsford.—At the meeting of the District Council a letter was read from Mr. G. W. Clark, of East Hanningfield, asking for permission to erect some poles to carry overhead some electric lighting wires. Mr. Clark has an electric installation of his own, and wants to supply one or two other residents of the parish with the light. The matter was referred to a committee.

Derby.—At the meeting of the Town Council, Mr. Naylor asked a question with regard to two new transformers that it was proposed to erect at a cost of £268. They were so unsightly that he should be pleased if the matter could be so reconsidered as to render their erection unnecessary. Alderman Leach said it was a matter that was under consideration, but they were unable to do it at present at any rate.

Northam.—Mr. Grant, the engineer for the electric power company, has been at Northam for four weeks seeking the most suitable spot on which to erect the works of his company. After exhaustive tests he has decided on locating them at East Northam. A huge dam for the company is being constructed on the Mortlock river. Necessary properties have been under offer some time, and will now be acquired.

Bury (Lancs.).—The new electric lighting works will probably be ready by the autumn. A deputation from the tramway company have met the members of the Sewering, Paving, and Streets Committee with reference to the working of the tramways in the borough by overhead electric traction, and a deputation has also been appointed by the Corporation to visit Bristol, where electric traction is in operation.

Colchester.—The Town Council have accepted Mr. A. T. Osborne's offer to sell for £500 a piece of land adjoining Stanwell-street depôt for an electric light station, as also the Colchester Brewing Company's offer to sell for £100 a piece of land 72ft. by 15ft., adjoining the north side of Mr. Osborne's land. It was reported that the plan of the district proposed to be lighted had been prepared, and tenders had been invited.

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Merthyr.—With regard to the provisional order applied for by Mr. Howell, of Llanelly, for the public lighting of Merthyr by electricity, the Urban District Council have received a letter from the Board of Trade stating that they had granted the order, subject to the area of supply being reduced from a mile to half a mile of the centre of the town. The Council approved of the restriction.

Amalgamation.—We are informed that an amalgamation has been effected between the Nalder and Harrison Construction Syndicate and Messrs. Swinburne and Co., Limited. For the purposes of this amalgamation it has been found advisable to dissolve the syndicate, and the amalgamated businesses will be in future carried on as a private firm under the title of Messrs. Nalder and Hilton, who have purchased the two businesses.

Newport (Shropshire).—The Lighting Committee's report, recommending the acceptance of the gas company's contract, caused considerable discussion at the meeting of the Urban Council, in the course of which a letter was read from Messrs. Robinson and Molyneaux saying they intended to lay down an electric lighting plant at their works, and would be prepared to light the district. Ultimately the report was adopted.

Halstead (Essex).—At the meeting of the Rural District Council the surveyor reported that he had received a report and plans from Messrs. Crompton and Co. on the matter of lighting the town by electricity. The report was referred to the Lighting Committee to report upon. On the suggestion of Mr. Clark, the surveyor was instructed to prepare a table showing the average cost of lighting the town and the public offices during the past three years.

Lurgan.—The Commissioners are considering the propriety of having the town lighted by electricity during the present season, and a committee has been in communication with an electrical engineer on the subject. It is proposed to supply 15 lamps, extending from the railway station to Queen-street, with elevated wires, at a cost not exceeding £500. The chairman of the Commissioners has been requested to confer with the Lord Mayor of Belfast, as an authority on the subject.

Mitchelstown.—We understand that preliminary steps are about to be taken by Mr. Webber, the landlord of the Kingston estates, to promote a scheme for the electric lighting of the town. It is understood that the Board of Guardians will be asked to give the necessary authority for the scheme. About 40 electric street lamps will probably be required, and it is expected that the principal inhabitants will contribute materially to the undertaking by using the light for domestic purposes.

Cable between Hawaii and Japan.—A telegram from Washington says that the Committee of the Senate on Foreign Relations have agreed to a compromise with regard to the Bill providing for a cable between the Hawaiian Islands and Japan. The Bill authorises the Postmaster-General of the United States to make contracts on behalf of the latter with any company that may undertake the laying of the new cable, and to pay them a Government subsidy not to exceed the sum of 160,000dol. per annum.

Oldham.—At the Town Council meeting, Mr. Harrop, on the minutes of the Electric Lighting Committee, commented upon the acceptance by the committee of Prof. Kennedy's recommendation limiting the firms to be asked to tender for the supply of dynamos by the insertion of a qualification that tenders would only be considered from those firms who had already manufactured plant of about the size required. On the suggestion of the town clerk, the chairman promised to take as an instruction to his department that invitations to tender be sent to Oldham firms.

Cambridge.—The following is the revenue return for the March quarter, 1896, of the Cambridge Electric Supply Company, Limited: number of units sold during quarter, 65,425; number of lamps connected March 31, 1896, 15 952; revenue from electricity supply, March quarter, 1896, £1,767. 10s. 9d., March quarter, 1895, £1,273. 3s. 3d.; revenue from meter rents and other sources, March quarter, 1896, £60. 19s. 1d., March quarter, 1895, £49. 13s. 6d.; total revenue, £1,828. 9s. 10d., as compared with £1,322. 16s. 9d. in the corresponding quarter of 1895.

Burnley.—At the meeting of the Town Council the General Purposes Committee were authorised to carry out the works necessary for the lighting by electricity of the technical school at an estimated cost of £205. The Gas and Electric Lighting Committee asked for permission to lay additional mains in Church-street for the supply of electric light at an estimated cost of £165. Councillor Thornbee asked if a sufficient number of promises had been given to justify a cable being laid in Church-street? Councillor Bibby replied that they had plenty of guarantees for the cable.

Bromley.—At the meeting of the Rural District Council the Works Committee reported that an offer from the National Telephone Company to provide fire-alarms in Durham-avenue, Beckenham-road, and Croydon-road was submitted, but as the company attached a condition that they should be allowed to erect telephone posts along the public highway for this purpose, and use posts, in addition, for the general business purposes of the company, the committee recommended that before considering the matter a plan be applied for showing the position of the proposed posts. The report was adopted.

Canterbury.—The following report of the whole house committee of May 1 (16 members present) was brought up at the last meeting of the Town Council: "The committee recommend as follows: (*a*) that electric lighting be established in the city by the Corporation, and that the necessary steps be taken for that purpose; (*b*) that Mr. R. Hammond, M.I.E.E, be engaged as the engineer to lay the mains and generally carry on the works; (*c*) that application be made to the Local Government Board for sanction to a loan of £20,000 to carry out the above works." The Council adopted the report by 13 votes to 4.

Appointments Vacant.—The Committee of the City and Guilds of London Institute have announced that they are prepared to appoint a professor of mechanical engineering and applied mathematics at the Finsbury Technical College. Besides classes, the professor will have to superintend the workshops and give instruction in machine designing and drawing. The salary is £600 a year; and application should be made to the hon. secretary at Gresham College, E.C., by June 8.—The borough of Salford are about to appoint a chief lecturer in chemistry for the Salford Technical Institute, at a salary of £200.

Stockton.—At the quarterly meeting of the Town Council a committee reported on the electric light, which would cost £18,000 to instal in Stockton for public purposes. The Board of Trade provisional order to the Corporation would expire in August next, and if the work were not commenced by that time a private company could step in. This was most undesirable, as the company would probably have to be ultimately bought out. The committee, having regard to the heavy rates, recommended that application be made to the Board of Trade for a further extension of time, during which the rates might be reduced. This was agreed to.

Crewe.—At the last meeting of the Town Council Councillor C. H. Pedley gave notice that he should bring before the next meeting of the General Purposes Committee the question of electric tramways for the town, running north, south, east, and west. He thought they would be a great boon to the inhabitants. He had reason to believe that it was possible to get someone who would not only obtain a provisional order, but would themselves lay down the tramway and work it when completed. He mentioned this so that the Council might think about it, for no one would apply for a provisional order except with the consent of the town.

City of London Electric Lighting Company, Limited.—The following is the gross revenue return for the quarter ended March, 1896: sale of current for public lighting, £3,161—corresponding quarter last year, £3,191; sale of current for private lighting, etc., £38,280—corresponding quarter last year, £26,622; other sources (estimated), £750—corresponding quarter last year, £340; total, £42,191—corresponding quarter last year, £30,153. This is an increase on the corresponding quarter of £12,038. The equivalent of 8 c.p. lamps connected on March 25, 1896, was 207,268, an increase during the quarter of 11,951; equivalent of 8-c.p. lamps connected on March 26, 1895, was 148,594, an increase of 13,134.

Catalogue.—We have received from Messrs. F. and C. Osler, of 100, Oxford street, W., a catalogue of designs of fittings for electric light. The catalogue contains illustrations of some graceful and handsome ornamental fixed and sliding pendants, ceiling lights, brackets, etc. There are some very pretty standard and table lamps, and some novel and graceful Royal Worcester porcelain figures, designed to carry electric lamps. A few French bronzes only are shown, but these are of a highly artistic order, and serve to illustrate the endless fields that are open to those who strive to combine utility and beauty. Messrs. Osler supply fittings at all prices, but even the cheapest are beautiful in outline and design.

Peterborough.—Mr. F. H. Tulloch, inspector of the Local Government Board, has held an enquiry with regard to the application of the Town Council for sanction to borrow £20,000 for electric lighting works. Mr. H. Percival, barrister, appeared to oppose for certain ratepayers, and Mr. Capell appeared for the Great Northern Railway. The objection raised by the barrister was that the margin of borrowing powers of the Corporation (£42,503) was pledged for duplication of the water-main, and for providing municipal and other offices, and they also objected to the smallness of the area to be lighted. Prof. Fleming described a scheme, and said there would be no difficulty in supplying the whole borough.

Newport (Mon).—The electrical lighting is progressing rapidly, and already it has become necessary, in consequence of the large number of applications for the light in Commercial-street, to increase the size of the low-tension mains in that section of the leading thoroughfare between Skinner-street and Hill-street. The small converters will be replaced by large ones, which will be sufficiently powerful to indicate finality. The capacity of the mains will then be sufficient in that part of the inner area to deal with all possible future installations. The small converters will be valuable for use elsewhere in the district. We understand that the Electricity Committee of the Town Council are considering an estimate of the cost of an extension to Maindee.

Hampstead.—At the meeting of the Vestry the Lighting Committee recommended that an electric main be laid in Abbey-road, from Boundary-road to Belgrave-road, for the supply of current to private consumers, at an estimated cost of £90. 15s. 6d. This was adopted. Mr. T. I. Johnson complained of the delay in presenting a copy of the electric lighting accounts to the Vestry, and enquired whether there was any probability of their being published before the elections. It was explained that the accounts, in the form prescribed by the Board of Trade, had been before the committee; but that, being of a complicated nature, the vestry clerk had been instructed to prepare a statement to accompany them. The accounts were always open for the inspection of any vestryman.

Aberdeen.—The Town Council have decided to proceed with an extension of the electric lighting works at an estimated cost of £4,500, and that two new boilers, with water-heater and feed-pumps, be obtained at an outlay of £3,000. It was also agreed

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that the main should be extended from Union street round Golden-square at an expenditure of £300, and the main in George-street for a distance of 40 yards beyond the Northern Hall. at an expense of £280; but that no action should in the meantime be taken as regards the subject of the extension to the west end of the city, and that the question of the extension of the mains to the harbour district should be deferred. A sub-committee is engaged in considering a scheme for the electric lighting of the harbour and quays.

Waterloo-with-Seaforth.—The following communication from the Board of Trade was read at the last meeting of the Urban District Council: "Sir,—I am directed by the Board of Trade to transmit to you the enclosed copy of the Great Crosby and Waterloo Provisional Order, in the form in which, subject to any observation they may receive, they propose to issue it, and to request that if the District Council have any observations to offer thereon this department may be favoured with them at the earliest possible moment." The Solicitor said the copy which had been sent down was practically an exact copy sanctioned by that Council previously. There had been one or two clauses inserted having reference to the Great Crosby district, but so far as Waterloo was concerned there was nothing more in it.

Swansea.—We understand that there is a possibility of the revival of the triple scheme, under which the Corporation proposed to establish a dust destructor, work the tramway system, and light the streets by electricity. It will be remembered that a Bill for the acquisition of the tramways was deposited in Parliament for promotion by the Corporation during this session, but it had to be withdrawn owing to a misunderstanding of the arrangement arrived at with the tramways company. We learn that there is now a chance that the Bill, or some modified form of it, may be revived even in the present session of Parliament, and that should the necessary arrangements not be made sufficiently early for this to take place, it will be proceeded with in the next session.

Dundee.—The question of providing an additional electrical storage battery for the city was under consideration at the last meeting of the Gas Committee of the Town Council. The estimated cost is £832. 10s. It was resolved to report the whole matter to the Town Council for their instructions. The new battery would exactly double the storage capacity, it being a duplicate of the storage battery at present in use. The Works Committee of the Town Council, after considering the proposal to lay underground telephone wires in Dundee, have decided to delay coming to a decision until a full report has been received from the burgh engineer. The sum collected for electricity rental for the 12 months ending April was £4,882 2s. 10d, an increase of £1.206. 17s. 6d. for the last year.

Elgin.—At a meeting of the County Council there was submitted a letter from Mr. John E. Gordon, M P., enclosing a communication from the Postmaster-General intimating that, after careful enquiry, he now saw his way to erect a telephonic trunk wire between Aberdeen and Inverness. The matter was now in the hands of the Treasury, and would be pushed on rapidly. There was also read a long communication from the County Council of Fife, accompanied by a request for the co-operation of Elgin County Council, with the view of obtaining from the Post Office special terms for the use of the telephonic system on trunk wires. According to the Post Office Act, the Post Office could give no modification at all on the present scale. Before that could be done a new Act would require to be passed.

Paddington.—At the last meeting of the Vestry, Colonel Barchard, the chairman of the Electric Lighting Committee, reported the result of the committee's application to the Metropolitan Electric Supply Company, Limited, for a reduction in their charges, which from Lady Day last will be as follow—viz.: for public and trade purposes—when the consumption exceeds five units per 8-c.p. lamp per quarter 5d. per unit, and when the consumption is less, 6d. per unit. The gallant colonel's report was received and adopted with evident satisfaction. He then moved and it was agreed: "That the Board of Trade be informed that this Vestry have no suggestion to offer with reference to the additional system of supply proposed to be adopted for the purposes of the Paddington Lighting Order, 1890."

Barrow.—The Town Council have decided that Mr. E. Manville be asked to visit Barrow and submit a report on the best system of electric lighting for the borough, with estimates of cost, maintenance, and probable revenue, and that before his visit the town clerk write the Furness Railway Company, the Barrow Hematite Steel Company. and the Naval Construction and Armaments Company asking whether, in the event of an installation being laid down, they would be prepared to take electricity for lighting or power, and if so, to what extent. It was also decided that the town clerk write Mr. Emile Garcke, representing the Barrow Tramways Company, asking whether, in the event of an installation being laid down, the company would be prepared to take electricity for the purpose of working their tramways.

Falmouth.—At the Urban Sanitary Authority's meeting the following letter was read from the Postmaster-General: "With reference to your letter of March 5, forwarding a petition from the Mayor, aldermen, and burgesses of the borough of Falmouth, asking for the extension of the trunk telephone system to Falmouth and Penzance, I am directed by the Postmaster-General to inform you that, after careful consideration, his Grace is prepared to recommend to the Lords Commissioners of the Treasury the erection of a trunk circuit to Falmouth. The Postmaster-General expresses his regret that the circumstances do not at present justify him in recommending the extension of the trunk system to Penzance, but he assures the memorialists that the claims of that town shall be borne in mind in the consideration of the extensions of the system."

London County Council.—At the meeting of the Council the Bridges Committee brought up a long report with reference to a proposed foot-passenger tunnel under the Thames between Greenwich and Millwall. The total estimated cost of the works would be £65,000, and of the land £5,000 It was proposed to light the tunnel by electricity, the committee having received an offer from the London Electric Supply Corporation to lay a cable to the tunnel for £1,000, and to supply electricity at 4d. per Board of Trade unit. The committee recommended that the Council should apply to Parliament for power to construct a foot-passenger tunnel at an estimated cost of £70,500, but this was postponed. Upon the recommendation of the Finance Committee it was agreed to lend the Vestry of St. Pancras £15,300 for electric lighting purposes.

Fareham.—The District Council have had before them a lengthy report on the necessary work in connection with the electric light undertaking which was presented by the electrical engineer (Mr. Manville). It dealt mainly with the best method of providing better lighting in certain streets, the replacing of certain lamps, and the cost of putting wires underground, in compliance with the Board of Trade requirements. The total cost he estimated at £1,428. The plant in the generating station also required duplicating, and he recommended the installation of a new arc light machine and a new alternator with two small engines—one to drive the alternator and one to drive the arc light machine. The cost of these duplicates he estimated at £1,025, this being the estimate for a complete new plant. The report was referred back to committee for consideration.

Belfast.—A deputation from the Paisley Commissioners visited the town a few days ago and went to the electric light station in Chapel lane, where they were received by the engineer, Mr. V. A. H. M'Cowen, who explained the working of the engines and the switchboard. The deputation was joined by the chairman of the Electric Committee of the Corporation (Councillor Andrews, J.P.) and Councillor Sir Wm. M'Cammond, J.P., and, after the chairman had informed the visitors of the origin and progress of the Corporation system of electric lighting and the probable development of the concern at no distant date, an adjournment was made, at Councillor Andrews's invitation, to luncheon, at which the party was augmented by the presence of other members of the Electric Committee The deputation seemed much gratified by the information they received during the day.

Douglas.—The laying of the lines of the Southern Electric Tramways is practically finished, and the work has been carried out in the most substantial manner. The building to contain the tramcars is finished, and the power station will shortly be completed. The three new steel bridges are on the ground, and one is erected in position, the other two being well advanced. The electrical machinery, all of the latest and most improved pattern, is on the ground, and the motors are being fitted to the cars as they arrive. The boilers are being placed in position, and all works are being actively pushed forward with a view to opening the lines for traffic in June. The present terminus of the lines at the south end of the Marine Drive is at the commencement of the footpath leading to Port Soderick, to which place it is proposed to extend the tramways at the end of the coming season.

Portsmouth.—A special meeting of the Electric Lighting Sub-Committee has been held to consider what steps should be taken to stop a disturbance among some of the stokers employed at the electric light station. It appears that a stoker was recently appointed to fill the place of one who had left, but as he was new to the work a young fellow, aged 18½ years, who had been employed in the coal bunkers at the station, was appointed to help the stokers, with whose work, it was said he was thoroughly familiar. Two of the men refused to work with their young mate, on the ground that he was only a boy, and should not be filling a man's position. It was pointed out at the meeting that the Trades Council laid it down that a lad over 18 years of age should receive a man's pay. After the two men objecting had given their explanation of the matter it was unanimously decided to dismiss them at once

Electric Lighting for Mar Lodge.—An exceptionally open winter has enabled the contractors for the Duke of Fife's new residence at Braemar to make substantial progress. Simultaneously with the erection of the house are proceeding the arrangements for lighting it by electricity. For this purpose his Grace has decided to utilise the Falls of Corriemulzie. Near the site of what was New Mar Lodge a reservoir will be formed, whence the water will be run through 12in. pipes to a turbine at the bottom of the ravine This wheel will drive the dynamo and generate the current, which will then be carried across the Dee on overhead wires to the new residence, adjoining Old Mar Lodge on the north side of the river. The water will give a force of 50 h.p., which will suffice not only for lighting, but also for heating, and probably culinary purposes. The falls will only be tapped at night-time.

Morley.—The Town Hall Committee reported at the last meeting of the Town Council that they had arranged with Messrs. Graham, Chapman, and Co. to continue the working of the electric light plant at the town hall for a few weeks on the same terms as the old contract. The Town Clerk said the committee thought it wise to make a temporary arrangement with Messrs. Graham and Chapman to continue as the electric light engineers of the town hall until the proposed scheme for lighting the town was started, when a man should be appointed to look after the whole. It was

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stated that it had been decided to fix the electric light to the stage fittings at the town hall in consequence of a suggestion made by the insurance company. It was supposed that the company considered it safer to have electric footlights for the stage, and the insurance tariff would be more reasonable if they adopted the suggestion. The report was adopted.

Liverpool.—At a meeting of the City Council Alderman Cookson moved a recommendation of the Health Committee that the Council consent to the National Telephone Company, Limited, laying their wires under the streets in the city on condition that the company undertake to substitute the twin-wire system for the present single-wire system throughout the city, subject to the company entering into an agreement with the Corporation, the draft of which had been approved by the committee. He mentioned that the Corporation paid somewhere between £800 and £900 a year for the use of telephones, and under this arrangement they would get back a minimum of £875 with an increased rent when the system extended. The Town Clerk, replying to several councillors, said the telephones were supplied to the Corporation at a considerably reduced cost compared to the cost of those supplied to ordinary subscribers. The recommendation was agreed to.

Coventry.—Mr. T. R. Whitehead, of Leeds, has been appointed secretary and manager of the tramways, vice Mr. H. O'Neill, resigned. At the meeting of the City Council, a certificate, in accordance with the terms of the agreement entered into in 1893 between the Mayor and Corporation and Mr. Graff Baker, was laid before the Council by the town clerk, showing the cost of the tramways undertaking. The amount, together with the expenses of the equipment, was shown to be £34 960. Mr. Andrews enquired whether details were given of the separate cost of buildings, cars, and so on. The Town Clerk said they were not given in the certificate, but they were set forth in the accounts on which the certificate was based, and which were considered confidential. The specification set out all the cost of roads, poles, cars, engines, and everything which is part of the tramways. On the motion of Alderman Tomson, seconded by Alderman Marriott, the certificate was ordered to be entered upon the minutes. Coventry will be connected with the postal telephone service on May 30.

St. George's, Hanover-square.—The special committee of the Vestry appointed to enquire and report upon the question of electric lighting and its relation to the destruction of dust and trade refuse have recommended that no step be taken on account of the great initial cost, and in the increase in the annual cost of the removal of the dust by the Vestry over the present cost of removal by contract, and also on account of the great difficulty of obtaining a suitable site within the parish. The committee, however, recommended that when the St James's Vestry carried out the lighting of Piccadilly by electricity, the Vestry should extend the lighting by electricity from St. James's-street to Knightsbridge at an annual cost of about £1,230 as an experimental trial. It was pointed out in the course of a discussion on this report that the cost of erecting the destructor and installing the light would be about £70,000. There was no open space in the parish for the erection of a destructor. The first part of the recommendation was carried, but the second, relating to the lighting of St. James's-street, was deferred, as there was a tie in the voting.

Blackpool.—The Electrical Committee have had before them the nine selected candidates for the post of electrical engineer. Ultimately the two following gentlemen were selected, from whom an appointment will finally be made: Mr. R. C. Quinn, of Brighton, and Mr. A. T. Cooper, of Blackpool. The final selection is to be made this week. A return has been issued showing the financial result of the working of the electric light department during the year ending March 25 last The return shows that the total receipts have been £6,865 17s. 6d., made up as follows: public arc lighting, £1,589. 19s 11d.; private arc lighting, £247. 6s. 1d.; and alternating current, £5,028. 11s. 6d. The cost of production at the electricity works was £3,904. 11s. 4d., equal to 2·7d. per unit. The chief items in the expenditure were: coal, £1,438; oil and waste, £277; water, £248; manager's salary, £200; electricians, £408; wages, £704; repairing (wages) £195; materials, £371. The total cost of the current produced, however, was £6 858. 3s. 4d., equal to 4·8d. per unit, the following items, of course, having to be added to the first cost at the works: rates and taxes, £110; insurance, £14; office and general expenses, £401; interest and sinking fund at 5¾ per cent., £2,428 The cars on the electric tramways will be running to St. Annes from Blackpool at Whitsuntide, and the whole length will, it is expected, be completed by about July, as the fine weather has enabled several gangs of men to push on with the laying of the metals.

Leeds.—The Leeds Corporation are about to further test the durability of a compound tramway rail patented by Mr. William Towler, a local citizen. About 18 months ago two 30ft. lengths of this kind of rail were put down as an experiment in a portion of North-street where the tramway traffic is very heavy. This experiment having proved entirely satisfactory, the Council, on the recommendation of the Highways Committee, have given an order to Mr. Towler for sufficient rails for one mile of single track. These will be laid down somewhere on the route of the proposed new electrical tramway between Sheepscar and Kirkstall. The ordinary rails now in use on tramways are solid pieces of metal, the usual 30ft. length weighing about 100lb. Mr. Towler claims that by the use of his patent inconvenient disturbance of the roadway might be obviated. His patent compound rail, as the name implies, is in two pieces, the upper portion of which can be removed and replaced when worn out without disturbing the lower portion of the rail. The necessity of pulling up more than a single row of paving stones on either side of the line is thus dispensed with. The upper part is secured to the under part by bending its flanges so as to clip the head of the under rail. This can be done by means of cramps, or by a special tool, that can be traversed along the rail, and which is fitted with a pair of adjustable rollers, which bend the flanges so as to grip the lower rail. The top rail, when worn out, it is said, can be readily detached by means of simple levers. Mr. Towler calculates that the upper part of his patent rail may be replaced at £572. 16s. a mile.

Worcester.—Colonel Marsh, Local Government Board inspector, has held an enquiry into the application of the Corporation for sanction to borrow £6,580 for purposes of electric lighting, and for the appropriation of £504 out of the enfranchisement money for the purchase of certain lands in Pitchcroft. The Town Clerk explained that the latter was a continuation of the scheme for acquiring Pitchcroft as a place of recreation for the city, a large portion of which had already been acquired. The money asked for in connection with the electric lighting of the streets was for an extension of the mains and additional lamps, and for work at the generating station. At the meeting of the Watch Committee it was reported that the Electricity Committee proposed to put another arc lamp in Barbourne, near the south end of Spreckley's brewery, instead of outside the Catholic Church, Sansome-place, and an additional one in the same road opposite Shrubbery-avenue, at a cost of £49. Alderman Williamson said that the authorities of St. George's Catholic Church had agreed to put the electric light into the church and schools if the Council would put a street lamp outside the church. But the church people had afterwards withdrawn from that agreement, and as there was no real public purpose to be served in placing a lamp there, it was proposed to be put where it was more wanted. Mr. Millington thought that was not the case. The Corporation withdrew from the agreement, and not the church people. It had been arranged to put the street lamp in an arch over the entrance. Alderman Williamson replied that the electrical engineer had understood that, whether the lamp was put there or not, the electric light would not be put in the church and schools.

Shoreditch.—The Electric Lighting Committee of the Vestry have reported that the Vestry's electrical engineers had reported upon the tenders for machinery, and the report had been carefully considered in detail. The tenders for Section A included the engines, generators, and other plant required within the generating station Nine firms tendered, and the committee recommended the Vestry to accept the tender of the Electric Construction Company for Brush engines at the price of £12,079, subject to guarantees, the contractors to replace at their cost the Brush engines in the event of the same not working to the satisfaction of the engineers with Willans engines, at an extra cost to the Vestry of £2,800, being the price of these engines over the price of the Brush engines. Eventually the Vestry decided to have the Willans engines. It was then moved that the contract for Section B should be given to Crompton and Co. An amendment was moved that the contract go to the Electric Construction Company, whose price was only £18 more than Crompton's. The amendment was carried. The Electric Lighting Committee also reported that they had received six tenders for Section B (steam and exhaust pipes, boilers, pumps, and cast iron work.) The committee recommended the Vestry to accept the tender of the Thames Ironworks Company at £4,500. This was agreed to. For Section C (motor transformers required for the sub-stations) the committee received 13 tenders, the highest amounting to £6,288, and the lowest—that of the Electric Construction Company—to £2,890. The tender of the latter was accepted. Ten tenders were received for Section D (the accumulator battery), and it was decided to accept that of Messrs. Pritchetts and Gold at £610. The highest tender amounted to £1 150

Tunbridge Wells.—The Electric Lighting Committee reported at the meeting of the Town Council that it was decided to extend the electric lighting mains in Madeira-park as houses were built. It was decided that 16-c.p. instead of 8 c.p. incandescent lamps be placed in street lamps, at a charge of £4 per lamp per annum. The following report from Mr. Boot was presented: "I have pleasure in presenting a short report of the progress of the electricity supply undertaking since the opening of the works last autumn.

	No. of lamps exclusive of public lamps.	Units generated at works.
October 1, 1895	740	4,117
November 1, 1895	2,694	8,782
December 1, 1895	3,350	10,747
January 1 1896	4,330	13,853
February 1, 1896	5,506	15,894
March 1, 1896	6,001	12 561
April 1, 1896	7 024	11 091

The machinery is only capable of supplying energy to 4 000 lamps, but by forcing our boilers and engines and using all the spare plant, we have been able to cope with the demand successfully, and by next winter when the extensions have been completed, we shall be in a position to supply 13,000 lamps exclusive of the public street arcs. The larger the demand the cheaper we are able to produce the unit, and thus, when 13,000 lamps are supplied, a considerable profit per annum will be made. It therefore becomes the duty of those interested in the reduction of the rates to use their influence to obtain as many consumers as possible."

York.—In answer to Mr. Alderman Wragge, who asked at the meeting of the City Council what had been the cost of the preliminary enquiries in connection with the electric light, Mr. Alderman Rymer said the amount paid of the rates for this purpose

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in the year 1890 was £52. 9s. 6d.; in 1891, £239. 19s. 4d.; in 1892, £53. 0s. 4d.; in 1893, £35. 13s. 1d., making a total of £381. 2s. 3d. Then there had been expended and placed to capital account to March 30, 1896, £110. 5s. paid to Prof. Kennedy, and a sum of £228. 3s., making with the amount already given a total of £609. 5s. 3d. That did not include the fee of 100 guineas to Prof. Kennedy for his present work. Mr. Lambert moved, "That the public debt of the city having reached approximately £500,000, owing chiefly to the extravagance of the School Board and the extraordinary cost of the new sewerage scheme (the estimated further expenditure on such scheme being at present an indefinite quantity), it is undesirable to enter upon any new scheme of a speculative character such as the adoption of an electric lighting system under municipal management or by means of municipal capital, and that the resolution passed by the Council, May 17, 1892 by which it was decided to keep the electric lighting of the city in the hands of the Corporation, be rescinded, together with any subsequent resolutions of this Council so far as such later resolutions commit this Council to any outlay of municipal moneys on the proposed undertaking." The motion was lost by 17 votes to 9. Mr. Alderman Rymer moved, "That it be an instruction to the Streets and Buildings Committee when they present their report on the electric lighting recommending a tender for acceptance, at the same time to furnish the Council with the probable number of ratepayers (founded on a canvass of the parts of the city proposed to be lighted) likely to use the light, and the number of lights they will probably require." This was seconded by Mr. Lambert, but lost by 17 votes to 14. At a meeting of churchwardens and overseers of the various York parishes a resolution was carried objecting to the scheme being undertaken by the Council.

Bath.—A special meeting of the Urban Sanitary Authority has been held to consider a report from the Electric Lighting Committee. This report recommended the Authority to accept Prof. Kennedy's valuation of the Bath electric light works, and to offer the company £24,533 as the price of their undertaking. A letter was received from the solicitor to the electric lighting company stating that, having regard to the report of Prof Kennedy, they were now prepared to accept the sum of £29 500, which amount was less than 15 years' purchase of the profit income of the concern. If the Corporation were unable to accept this proposal, the company asked that they would appoint representatives with full powers to meet the company's representatives at a meeting at the offices of the Board of Trade, as suggested by them in their letter of April 29. Alderman Sturges reminded the Authority that the company originally required £45,000 for the undertaking, a price which the Authority considered very high, while Mr. Hammond, acting for the Corporation, put it at £16,000. There was such a wide divergence of opinion between the company and the Corporation at the conference before the Board of Trade, that Sir Courtenay Boyle suggested revaluation by an independent valuer. Prof. Kennedy was appointed, and his valuation was, if he might describe it so, a sort of halfway house. His price was £22,733, and his valuation the committee, at their meeting on Saturday, were unanimous in accepting. They had always assured the company that they were desirous of dealing with them fairly Then there was an item for the land which was not included in the £22,733, or in Mr. Hammond's valuation of £16,000 After some little trouble they fixed upon Mr. Willcox, the county land surveyor, to make a valuation in respect to this item, which the company themselves valued at £2.000 and the price which Mr. Willcox fixed at £1,800 The committee were very distinct in recommending the purchase at the items of £22,733 and £1,800 Mr. Morris seconded the resolution, which was carried. It was also decided that a deputation should attend the Board of Trade offices, as suggested by the assistant secretary, and that the whole matter should be remitted to the committee with full power to settle and agree to the purchase of the undertaking on the basis of the recommendation contained in their report. At a meeting of the Sanitary Committee the Statutory Hospital Committee recommended that the hospital be lighted with gas, but in view of the prospect of the town becoming proprietor of the electric light works it was decided to defer the matter.

Brighton.—At the meeting of the Town Council the Lighting Committee reported that they had agreed on the sites for arc lamps to be erected in accordance with the report of the committee of January 6 last, except those it was proposed to place in Norfolk-road. It was resolved that two arc lamps be erected in Bedford-square instead of Norfolk-road. A letter was read from Mr. W. L. Madgen, enquiring if the Council would subscribe to the Municipal Electrical Association, and inviting the attendance of members of the committee at the first annual convention of the association to be held on June 10 11, and 12. It was resolved that the Council should subscribe a sum of £1 1s. annually to the Municipal Electrical Association, and that the chairman be requested to represent the Council at the convention. On the motion of Councillor Stafford these proceedings were agreed to. The Lighting Committee reported on tenders received for supplying and delivering cast-iron and drawn-steel bracket posts for suspending electric light arc lamps, and recommended the Council to accept the tender of Messrs. Hart, Son Peard, and Co., Limited, of Birmingham, to supply and deliver 80 posts in accordance with drawings and specifications prepared by the borough surveyor for £2,500 with a further price of £31. 5s for each additional post ordered. The tenders included one from Messrs C. S. Mallet and Co, of London, whose price was £1,880 for 80 and £24 each additional post (tender since withdrawn), and one from Messrs. Reed and Son, of Brighton, at £2,460 for 80 posts, and £30. 15s. per additional post. The committee also submitted tenders for supplying 100 double-carbon arc lamps, including the fixing of 95 of such lamps in standards erected in the borough, and recommended the acceptance of Messrs. Crompton and Co.'s tender at £2 200. Councillor Stafford, in moving the adoption of the recommendations of the committee in this report observed, as to the tenders for the lamp standards, that the committee had not selected the lowest tender—that of Messrs. Reed and Son—but recommended the acceptance of the tender of Messrs. Hart, Son, and Peard, whose tender was slightly more than that of Messrs. Reed. As to that, he wished to say the committee took this into their very careful consideration, and though they were unanimously of the opinion that they would like a local man to have the contract the committee were influenced in favour of Messrs. Hart Son, and Peard because they had been successful on the first occasion and had made the standards now existing in the town, and because it was very important that they should have these standards furnished by the end of August Messrs. Hart, Son, and Peard had all the plant and particulars, and having served the Corporation well the committee felt justified in offering them this contract. The committee had no feeling in the matter, and if the Council expressed a wish that they should accept the lowest tender they would be quite prepared to fall in with that wish, the Council taking the responsibility. Councillor Armes then proposed an exception that the tender of Messrs. Reed and Son be accepted. He believed Messrs. Reed and Son were as capable of carrying out this work as any Birmingham firm, and he held that, as far as possible, they ought to give their work to local tradesmen. Alderman Davey seconded. The exception was carried unanimously. The recommendations, as thus amended, were then agreed to.

County of London and Brush Provincial Electric Lighting Company, Limited.—This Company announce a second issue of £10,000 cumulative 6 per cent. preference shares at a premium of £2 per share, which are offered for subscription on behalf of the Company by the Electric and General Investment Company, Limited, 1 and 2, Great Winchester-street, E.C. The prospectus states that the present issue of 10,000 preference shares is made in order to provide funds for the further development of the Company's business, and, in allotting, applications received from registered holders of existing preference and ordinary shares of the Company will be preferentially considered. It is not intended that the balance of 20,000 preference shares shall be issued except at a higher premium than that at which the present issue is offered. The audited balance-sheet of the Company at December 31, 1895 shows capital expenditure as follows: county of London stations—land, buildings, machinery, plant, mains, etc., £137,065. 3s. 9d.; provincial stations—investments in and advances to associated electricity supply companies, £156,019. 4s. 2d.—total, £293,084. 7s. 11d. This figure has been increased by expenditure incurred since the above-mentioned date. Dividends at the full rate of 6 per cent. per annum have been paid on the existing preference shares for the year ended December 31, 1895, and the directors consider that the earnings of the Company during the present year will be sufficient to pay the dividends on the preference shares, including the present issue. The Company holds provisional orders, confirmed by Acts of Parliament, for the following districts in the county of London: the united parish of St. James and St. John, Clerkenwell; the parish of St. Luke, Middlesex; the district of the Wandsworth District Board of Works, including the parishes of Wandsworth, Putney, Clapham, Balham, Tooting, and Streatham; the parish of St. George-the-Martyr Southwark; and the district of the St Olave District Board of Works. In the St. Luke and Clerkenwell districts the whole of the street work in the compulsory areas has been completed, and the station buildings are far advanced. Applications have been received for the equivalent of 7,000 8 c.p lamps, of which 6,000 are connected to the Company's mains, and the directors anticipate that there will be a sufficient number of lamps applied for by the time the station is completed to ensure a profit being earned from the commencement of working the plant. In the Wandsworth district the cables are being drawn in, the transformer sub-stations are in course of construction, and the generating station on the River Wandle is making rapid progress. The plant now on order for the St Luke and Clerkenwell and Wandsworth stations will be capable of supplying 99,000 8-c.p lamps, and the buildings for these stations will be sufficiently large to accommodate plant of more than double this capacity. The Company have applied to the Board of Trade for a provisional order for other areas in South London, and an order has been granted for the parish of Camberwell, subject to confirmation by Parliament. With regard to the undertakings in the provinces in which the Company hold controlling interests, the station buildings at Bournemouth have been remodelled and enlarged, and considerable extensions of mains have been carried out within the past year, The plant is capable of supplying 27,500 8-c.p lamps, and connections equivalent to 21,000 8 c.p. lamps have been made. The Dover station was completed last year, and an uninterrupted supply of current has been given since April, 1895. The plant is capable of supplying 11,000 8-c.p lamps, and 5 800 8-c.p lamps are already conected. Considerable extensions of mains have been made during the past year, and further extensions are now in progress. The plant is capable of supplying 9,500 8-c.p lamps, and 5,900 are now connected The preference and ordinary shares already subscribed are quoted in the Stock Exchange official list, and in due course application will be made to include the present issue in the quotation. Prospectuses and forms of application can be obtained from the bankers, the brokers, the Electric and General Investment Company, Limited, and at the offices of the Company. The list of subscriptions opened yesterday and closes to-day (Friday).

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PROVISIONAL PATENTS, 1896.

MAY 4.

9402 Improvement in electric gas-lighting devices. Oscar von Morstein, 89, Chancery-lane, London. (Complete specification.)

9447. Improved reversible variable speed gear applicable for use in electrical regulation and other purposes. Arthur George Cooke, 70, Chancery-lane, London.

20542A. Improvements in or connected with apparatus for the electrolytic decomposition of liquids. George Bell and George William Bell, 15, Water-street, Liverpool. (Date claimed under Patents Rule 19, October 31, 1895.)

MAY 5.

9480. Improvements in electrical contacting devices for subways or conduits. Alvaro S. Krotz, William P. Allen, and Oliver S Kelly, 5, John Dalton-street, Manchester. (Complete specification.)

9517. Improvements in electric locking and block signalling on railways. William Robert Sykes and Frederick Thomas Hollins, Liverpool street Station, London.

9528. Improvements in telegraphic relays and the like. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London (Charles G. Burke, United States.) (Complete specification.)

9530. Improvements in sockets or holders for incandescent electric lamps. James Devonshire, 70, Chancery-lane, London. (Herbert C. Wirt, United States) (Complete specification.)

9531. Improvements in dynamo-electric machines. James Devonshire, 70, Chancery-lane, London. (Charles P Steinmitz, United States.) (Complete specification.)

9534. Improvements in electric switches for use with or without mechanical or electromagnetic brakes. John Lavender. 23, Coleman-street, London.

9537. Improvements in or relating to electro-mechanically propelled vehicles. John Lavender, 23, Coleman-street, London.

9555. Improvements in or connected with electric burglar and other alarms. Thomas Alfred Clarke, 6, Lord-street, Liverpool.

9565. Improvements in or connected with electric melting apparatus. Martin Schindler, 46, Lincoln's-inn fields, London.

MAY 6.

9619. Improvements in incandescent electric lamps. Samuel Phillips Eastick and Egerton Sayer, 47, Ashford-road, Cricklewood, London.

9637. Improvements in arc lamps. Antoine Blahnik, 47, Lincoln's-inn-fields, London.

9650. Improvements in electromotors and dynamos and in apparatus for use therewith. Emil Lanhoffer, 322 High Holborn, London. (Complete specification.)

MAY 7.

9667. Electric arc lamps. William Fox, 4, Bramley-street, Broughton, Lancs.

9668. Electric arc lamps and projectors. William Fox, 4, Bramley-street, Broughton, Lancs.

9681. An improved method of street lighting by glow lamps Horace L. P Boot, The Town Hall, Tunbridge Wells, Kent.

9713. A signal indicator for use on locomotives and means for electrically operating the same. David Foulis, 115, St. Vincent-street, Glasgow.

9758. Improvements in floorcloths or carpets for the purpose of electrical distribution therein. Ferdinand Fanta, 1, Queen Victoria street, London.

MAY 8

9806. Improvements in apparatus or devices for starting and arresting electromotors employed in driving wire-drawing or other similar machines. Henry Pieper Fils, 47, Lincoln's-inn fields, London.

9817. Improved shade for use in connection with electric incandescent lamps and the like. Elizabeth Bach, Henry Sylvester Lewis, and Alick Boyd Saunders, *Invention* Office, Mitre-court, Fleet-street, London. (Complete specification.)

9820. Improvements in coupling boxes for electrical circuits. Max Binswanger and Francis George Bell, 73, St. Stephen's-road, Upton Park, London

9832. Improvements in telephone systems of exchange. John Edward Kingsbury, 24, Southampton buildings, Chancery-lane, London (The Western Electric Company, United States.)

9843. Improvements relating to electric current meters. Reginald Page Wilson, 70, Chancery-lane, London.

MAY 9.

9910. Improvements in secondary batteries. Alexander Schanschieff, 77, Chancery-lane, London.

9919. Improvements in and relating to exhausted tubes for electrical and other purposes. William Friese-Greene, 55, Chancery-lane, London.

9929. The self-returning electric bell indicator. Reginald W. Lane, 125, Denmark-hill, London.

SPECIFICATIONS PUBLISHED.

1887.

4664. Electric furnaces. Thompson. (E. H. and A. H. Cowles.) (Third edition.)

1890.

2504. Electrically propelling vehicles, etc. Wynne. (Second edition.)

1894.

9285 Electrodes. Kellner. (Second edition.)

15082. Magneto-electric machines for cycles, etc. Tilmann and Lexow. (Second edition.)

15276. Diaphragms for electrolytic purposes. Kiliani and others (Second edition.)

1895.

962. Electric railways. Stendebach.

7712. Electric furnaces. Burton

7713. Electric furnaces. Burton.

11482. Telegraph cable, etc., lines. Taylor and Dearlove.

11548. Telephone systems. Kingsbury. (Western Electric Company.)

11549. Telephone systems. Kingsbury. (Western Electric Company.)

11560. Electric mains or conductors. Aldridge.

11709. Alternating-current machines. Johnson and Steele.

11892. Arc lamp. Hepworth.

12301. Dynamos, motors, and alternators. Atkinson.

12394. Indicating telephonic communications. Kosanke and others.

13961. Electric tramways and railways. Lake. (Compagnie de l'Industrie Electrique of Geneva – Usine de Secheron.)

23852. Electrolytic diaphragms. Bromhead. (Société Anonyme des Anciennes Salines domaniales de l'Est Actien Gesellschaft.)

1896.

434. Electric switches. McKenna. (Electric Selector and Signal Company.)

4808. Electric brakes for railway and tramway vehicles. Devonshire. (Potter.)

5098. Electrolytic processes. Baldo.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅞-6¼
Brush Company, Ordinary	2	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2	1⅝-1⅞
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	8 8½
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7½-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16½-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	41-43
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14⅞-15½
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	5	1½-1⅝
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	1½-1⅝
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	⅞-1
Elmore's Wire Company	2	⅞-1
Fowler-Waring Cables	—	—
W. T. Henley's Telegraph Works, Ordinary	10	16½-17⅜
—— 7 per cent. Preference	10	16½-17½
—— 4½ per cent. Debentures	100	109-113
House-to-House Company, Ordinary	5	3⅜ 3⅝
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	23½-24½
—— 4½ per cent. Debentures	100	—
Kensington and Knightsbridge Ordinary	5	8½-9
—— 6 per cent. Pref.	5	7½-7⅝
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	14⅜-14½
—— 5 per cent. Pref.	10	17-17½
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	1-1⅛
Metropolitan Electric Supply	10	14-16
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7⅜-8
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6½-7
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	9-9½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5½
St. James's and Pall Mall, Ordinary	5	10½-10⅝
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	6	8½-8¾
Westminster Electric Supply, Ordinary	5	9½-10
Yorkshire House-to-House	5	7-7¾

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NOTES.

The Junior Engineers.—The Institution of Junior Engineers has arranged a visit to the Fowler-Waring cable works at North Woolwich on May 30.

Cable to Germany.—The new telegraphic cable between Germany and England is to start from Borkum, one of the Frisian islands, and land at Bacton, a village on the coast of Norfolk, between Yarmouth and Cromer.

Fatal Accident.—Last week a young man named Bates unfortunately made contact with his hand with a high-tension wire at the St. Mary's station of the Bedford Corporation electric lighting works, and received a shock which caused his death.

Meteorological Society.—At the last meeting of the Royal Meteorological Society, Mr. P. H. Curtis's paper on anemometers was taken. The conclusion arrived at was that for anemometrical records to be reliable and of value, not only must the instrument be exposed in an open place, free from local obstructions, but it is also absolutely essential that the stand which carries it shall offer practically no resistance to the wind. The instrument, for instance, should not be placed on the roof of a house.

Electrical Congress at Geneva.—The subjects to be discussed at the International Electrical Congress to be held at Geneva in connection with the Swiss National Exhibition are five in number—namely, magnetic units and their proper names, photometric units, long-distance transmission of power and the question of the employment of alternating or continuous currents for that purpose, the protection of high-tension lines from atmospheric discharges, and, lastly, the various troubles caused by electric tramways.

Northumberland-avenue.—On Monday the *Pall Mall Gazette* alarmed the town with a report of an electrical fire in Northumberland-avenue. Information as to the precise cause of the occurrence is not available, but it appears that what happened was that two wires in the County Council's subway heated and ignited some of the guttapercha insulation. There was naturally an amount of smoke and not a little smell, but nothing more serious resulted than the drawing out of a quantity of cable for inspection and repair and its subsequent replacement.

North-East Coast Engineers.—The programme of the summer visit of the North-East Coast Institution of Engineers to Cardiff, which is to take place on Tuesday, June 23, assigns that day to a visit to Newport and the Alexandra Dock, and a trip up the Usk; Wednesday is devoted to Cardiff Docks, the Dowlais Works, and the Cardiff Exhibition, with a smoking concert in the evening; on Thursday morning papers are to be read by Mr. J. F. Walliker and Mr. J. R. Fothergill, and the afternoon is given up to Barry; on Friday the meeting closes with a trip to Ilfracombe.

Lighthouse Communication.—It is stated that in consequence of the serious difficulties which continue to be experienced in maintaining electrical communications with certain light-vessels on the system now employed, the Royal Commission on Electrical Communication with Lighthouses and Light-Vessels have decided to postpone their final report until attempts have been made to overcome them. Meanwhile they have presented an interim report, which states that, as far as the lighthouses are concerned, the cables which have been laid on their recommendation have worked satisfactorily.

A New Cell.—A new cell is described in *L'Electricien*, the main feature of which is the short distance between the plates. It is a carbon-zinc combination. The carbon is channelled down one side and filled in with a paste made of powdered carbon and manganese dioxide. The zinc plate is amalgamated in the usual way, but is only separated from the carbon by a piece of coarse felt of small thickness. The liquid is a solution of two parts by weight of sal-ammoniac to one part each of common salt and chloride of zinc. It is stated that a cell about 6½in. high will give four amperes at 1·5 volts, but nothing is said as to the duration.

The Moscow Coronation.—According to the *St. Petersburger Zeitung*, the coronation of the Czar at Moscow is to be the occasion of a good deal of electric lighting. Besides the lighting of the Kremlin Palace, barracks, arsenal, etc., the Ivan Veliki bell tower is to be illuminated, or rather has already been so, since a trial illumination was made on the occasion of the Russian Easter. From telegrams to the daily papers, it appears that the house frontage of the principal streets of Moscow is almost entirely concealed by flags, garlands, and electric lamps, and decorative devices, while the rehearsals of the electrical illuminations have collected large crowds.

Movable Lightning Conductor.—According to the *Centralblatt der Bauverwaltung*, Mr. E. Hommert, of Coburg, has gone to the trouble of inventing and patenting a movable top for lightning conductors. A tube with a pulley is rigged on the top of the chimney shaft or building to be protected, and the top, which is weighted to keep it upright, is hauled up and down by a wire passing over the pulley and through the tube. If, therefore, there are in Germany or elsewhere any persons who would like to be constantly hauling their lightning conductors up and down, and, perhaps, of substituting ones of superior quality and appearance on Sundays and holidays, their wants can be supplied.

Lord Kelvin on Lamps.—Lord Kelvin has been giving evidence before the House of Commons Committee on the question of the Petroleum Acts in connection with the public safety. He thinks the sale of paraffin for ordinary use of a lower flashing point than 130deg., open test, ought to be prohibited by law, but does not think it would be wise to introduce legislative restrictions on the manufacture and sale of lamps. In fact, so far as the petroleum lamp is concerned, he despairs of introducing safety by legislation. It seems that the most dangerous lamps are not in poor houses but in fine drawing-rooms. Some of those on tall stands with large crystal reservoirs would make a very bad accident if they fell over. On a balance of evils, Lord Kelvin prefers metal to glass reservoirs, but jokingly suggested that the ideal would be an aluminium reservoir with a Röntgen ray to see inside of it.

The Hæmostat.—Demonstrations have been given lately by Mr. Lawson Tait of his electric hæmostat, an instrument which, as the name denotes, is intended for the arrest of bleeding in surgical operations. A platinum wire, arranged to carry a current, is enclosed in the blades of a pair of steel forceps, or any other requisite instrument, the wire being isolated by a bed of burnt pipeclay. A current of suitable voltage is turned on, the artery seized and compressed, and in a few seconds the tissues and arterial walls are so agglutinated that the passage of blood is rendered impossible. The temperature employed is about 180deg. F., so that it will be seen that the principle is fundamentally different from that of electrical cauterising instruments. It is stated that by Mr. Tait's instrument the necessity for a ligature is removed, and a new and completely effective

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method is placed in the hands of the surgeon for the treatment of surface oozing.

Motorcart Legislation.—The Bill for legalising motorcarts has got through the committee stage in the Lords. In the committee on Tuesday night, Lord Harris moved to amend Clause 1 by substituting four tons for two as the maximum weight of unladen vehicles exempted from enactments restricting the use of locomotives on highways. Lord Thring agreed, but suggested that some limit should be placed on the load that the vehicle might carry; and the Earl of Kimberley said that as many improvements would be made in the development of these vehicles, power should be given to make by-laws to meet unexpected changes and inventions. Lord Harris said it would be ridiculous to expect carriages carrying persons to be weighed whenever a policeman or someone else demanded it. But he asked their lordships to accept the Bill now, as he was not empowered by Mr. Chaplin to accept any suggestions at present for further amendments in the Bill. The amendment was then agreed to, and after some further debate the Bill passed the committee.

Portable Lighting Plant.—An article in the *Elektrotechnischer Anzeiger* is devoted to the subject of portable electric lighting plant, and in particular to the type manufactured by Messrs. C. and E. Fein, of Stuttgart. Two illustrations are given. In the first, a vertical boiler, engine, and a dynamo directly coupled to it, are arranged longitudinally on a rectangular iron frame carrying the wheels. The latter look somewhat small if the machine is to be taken far over rough country. The form of the vertical boiler is that of a truncated cone with the smaller end downwards, probably to bring it within the longitudinal limits of the frame. In a larger type of plant, a horizontal boiler is adopted, with a single-cylinder engine above it, on the plan of the ordinary portable engine. The dynamo is carried in front on a heavy bracket bolted on to the smoke-box, and is driven from the flywheel by a leather belt. Both engines have a somewhat curious look to the eyes of anyone accustomed to the forms of English designs, and this unusual appearance is not lessened by the presence of a feed-water heater in the larger of the two engines.

Erratum.—We regret that a laughable mistake was made in our last week's note headed "Units"—"the temperature of melting ice" being printed as "the temperature of melting glass." One of our esteemed contemporaries, in carefully looking through our columns in search of the Institution debate for abstraction, discovered the mistake and has kindly pointed it out to us. We regret that the Institution debate was crowded out by the account of the Dublin tramways, and hence that the absent president takes credit for Prof. Ayrton's remarks in our contemporary's columns. Before seeing the gentle reminder in our contemporary we had written the following: Accidents happen in the best regulated journals, and hasty writing caused a decidedly absurd slip in these columns last week, from which it appeared that the French Government wanted people to use as a standard the resistance of a column of mercury measured "at the temperature of melting glass." Infallibility is the last thing claimed by the writer of these notes, and as all our readers know that the substance whose melting point fixes the temperature of 0deg. C. is not glass, it is to be presumed no one troubled to speculate how such a remarkable measurement is to be made.

The University of London.—The correspondence on the London University question continues in the *Times*. Sir George Young contributes a letter which is absolutely unintelligible to anyone who has not the report of the commission at his side. He, however, does not agree with Prof. Ramsay, denies—under conditions—the "practical unanimity," and wants to have done with "phrase-making.' Mr. T. B. Napier goes further, and says that "in the University of London there is an overwhelming consensus of opinion against the recommendations of the commissioners," while Dr. W. J. Collins remarks that "the consensus of opinion, which is held to be so remarkable, appears to be chiefly limited to a desire for forcibly throwing the university into the melting pot without having taken the trouble to form any very clear ideas as to the sort of thing it is hoped will eventually emerge therefrom," and adds that the support of University College was only secured on the understanding that under the new scheme all examinations are intended to be, unless otherwise specially ordered, different for external and internal students. All of which shows the extreme difficulty of trying to be two different things at the same time—viz., what is usually implied by the term university and what is quite a different thing—namely, an examining board for the British Empire.

Motorcarts.—There are some people who are unkind enough to say that oil-driven motorcarts smell and shake. It is satisfactory to learn from the statement of a director at the meeting of the Daimler Motor Company on Tuesday that it is not so. "When you go along the little smell that there is is left behind you." It seems a pity that the vibration cannot be left behind in the same way. Moreover, it is added that "when you see the car standing still you form an absolutely wrong conclusion as to both the smell and vibration." It must be remembered that it is one of the interesting peculiarities of the oil motorcart that, although the cart is stopped, the engine keeps on going just the same. It is doubtless unreasonable, but, all the same, people who will put up with a certain amount of irregular shaking while they are going will object entirely to a regular and steady vibration while they are stopping still. Although many persons have supposed that horses are about to be entirely superseded by motorcarts, it is believed that up to the present the "noble animal" has not realised it. But at Eastbourne on Tuesday, where a couple of motorcarts were a feature in the procession in connection with the battle of flowers, behind one of them there sorrowfully walked a horse clothed in a rug bearing the inscription "R. I. P." It is sincerely to be hoped in the interest of the horse that that particular motorcart was not one of those that "leave their smell behind them."

Carbon and Permeability.—In his paper read before the Institution of Civil Engineers on "Magnetic Data of Iron and Steel," Mr. H. F. Parshall remarked that a study of the results of magnetic tests and their comparison with those of the chemical analysis showed a more or less intimate relationship according to the degree with which the modifying physical conditions might be controlled. In general, a greater degree of purity was an indication of high permeability, but as the different qualities of iron and steel merged into each other by insensible degrees, owing to variations in the processes of manufacture, chemical analysis might be taken only as an approximate indication of the magnetic properties. Carbon was the most important element entering into the composition of commercial iron, and, within the limits that chemical analysis might serve as an indication of the physical structure, the permeability was inversely as the amount of carbon present. The limitation as to the state of physical structure was greatly affected by the state of the carbon, that is, whether free or combined; in cast iron, as well as in steel, the effect of graphite was second

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to that of the carbide, commonly known as fixed or combined carbon. Beyond a certain degree of purity, as in wrought iron and carbon steels, the treatment as to annealing and tempering became of first importance. The magnetic properties of some of the alloys of iron, nickel, or manganese were such as to show that the physical structure was the ultimate determining factor. The hysteresis loss was, in general, inversely as the degree of purity, but in comparatively pure irons it was determined principally by its treatment as to annealing, heating, and mechanical straining.

Production of Three-Phase Currents.—Mr. E. Hospitalier has called attention in *L'Industrie Electrique* to a system devised by Messrs. Galileo Ferrari and Riccardo Arnò by which a high-tension alternating current is transformed into a low-tension alternating current in the usual way for lighting purposes, or, if wanted, into three or polyphased currents for power as the circumstances of the case may require, and which it is believed will prove convenient where it is desired to introduce motors on a distribution system originally intended for lighting only. The main point is the adoption of a new kind of rotary transformer, which, while performing the ordinary function of reducing the voltage, also shifts the phase of the induced current by a quarter period. For this purpose two fixed coils and a rotating armature are used. A transformer of the ordinary type, of course, is used to give the other phase. Without endeavouring to detract from the originality of Messrs. Ferrari and Arnò's plan, Mr. Hospitalier calls attention to the communication made as far back as 1894 to the Société française de Physique in which Mr. A. Potier proposed to obtain diphase or triphase currents from a transformer with a rotating armature that was practically an alternating-current motor with additional coils. In this case, however, the rotary transformer alone was sufficient. The whole subject is one that has engaged attention both on this side of the Atlantic and in America. There are obviously many more ways than one of obtaining the end desired. A good deal more practical work will have to be done before it is determined when and in what way it is desirable to work triphase or polyphase motors from an alternating system, and until then questions of priority may very well stand over.

Fuses Again.—They are still discussing the fuse question in America, where they seem to expect a very great deal more from fuses than they are likely to get in this world of imperfect appliances. The San Francisco *Journal of Electricity* makes some remarks on the subject which may be worth reproducing. "On beginning an examination of the numerous investigations which have been made on the subject," says our contemporary, "it will be noticed that the usage of fuse wires for protecting electric circuits seems to have been materially changed from the purposes to which they were designed by those proportioning them in the early history of the art. When the fuse wire was originally adopted it was intended to protect the conducting wire of the circuit from being overheated, and at that time it was well understood that the fuse could not be expected to protect the machinery installed upon the circuit; in every instance the fuse was adjusted to the carrying capacity of the wire which it was to protect. All of the recent studies of the fuse-wire question have turned upon their ability to protect machinery attached to the conducting circuit, and while in the first case the amount of energy passing over the fuse before its temperature reached the melting point determined its size, in the more recent investigations of the fuses the criterion of quality has been assumed to be the value of the current necessary to melt the fuse. Why the extensive experiments that have been performed on the basis of this second hypothesis should have been necessary is an exceedingly difficult question to answer, for the reason that anyone examining the conditions necessary for raising a given piece of metal to its melting point by the means of the passage of an electric current will at once find that the melting point is a time function of the energy, and in consequence cannot be stated in terms of current. Nothing further than a confirmation of this theoretical deduction has been derived from the experiments performed."

Another Large Power Plant Completed.—The General Electric Company, of New York, have just handed over to the owners the works in connection with the Folsom-Sacramento scheme. The electric plant consists of four 750-kilowatt three-phase generators direct coupled to 1,250-h.p. turbines of McCormick type, with horizontal shafts. The alternators have 24 poles, which, when running at a speed of 300 revolutions, give a frequency of 60 complete cycles per second. The voltage at the generator is 800. From the generators the current passes to the switchboards and thence to nine step-up transformers in the upper storey of the power-house. The capacity of each transformer is 250 kilowatts when cooled by an air-blast. In this transformation the pressure is raised from 800 volts to 11,000 volts, at which pressure the current passes to the high-tension lines, by which it is transmitted from Folsom to Sacramento. The distance is about 24 miles. The pole line is double throughout, and each pole carries two cross-arms for two circuits. Each circuit consists of three bare copper wires supported on double-petticoated porcelain insulators. Each circuit can carry the output of one alternator, and any alternator can be thrown on any line. The line loss when transmitting 3,000 h.p. is calculated at 7·5 per cent. A telephone line is carried on the same poles as the main-line wires. These latter are, however, spiraled every mile and the telephone wires are transposed every fifth pole, which is said to nullify the induction effects. At Sacramento the current is again transformed down. The largest consumer at present supplied is the Sacramento street railway, which takes current for 32 motorcars and trailers, running on 24½ miles of single and 17 miles of double track. The current for this work is supplied at 500 volts by machines somewhat similar in design to that used on the Dublin-Dalkey lines, described fully in our columns last week. The water-power works from which the water to drive the turbines is obtained are fully described in the *Electrical Journal*, from which paper we take the above data.

Frequency.—The tendency of the American engineers to endorse the Continental practice of using low frequencies with alternate-current work is well brought out in a series of articles now running in the *Electrical World*. We have always advocated the same course, and hence are pleased to publish the returns of the General Electric Company, of New York, who use low frequencies. All the old single-phase generators designed by this firm were for 125 cycles per second, but the latest types are designed for 60 cycles. There is no reason why motors cannot be operated on circuits of any frequency, but in order to get them comparatively small, and at the same time adapted to low speeds, frequencies lower than 125 must be adopted. The drop in the line is another factor of great importance. The reactance voltage—that is, the drop due to self-induction of the line—is directly proportional to the frequency, and consequently with twice the frequency there is twice the reactive drop. The total drop—that is, the impedance drop—is the square root of the square of the ohmic drop plus

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the square of the reactive drop, and consequently the total drop n the line is greatly increased as the reactive drop increases. From what has just been said it would appear that low frequencies are preferable, but transformers used on low-frequency circuits are necessarily larger for the same output than those required when higher frequencies are employed. Consequently, a mean between the two must be chosen, the higher frequencies being avoided, owing to the greater drop in the line and the necessarily high speed of generators and motors, while it is practically impossible to operate incandescent lights below 25 to 30 cycles per second, and arc lights below 40 to 45 cycles, owing to the perceptible flickering. It is chiefly for these reasons that the General Electric Company has adopted 60 cycles as a standard. But in special cases, as, for instance, in transforming alternating currents to continuous currents, it is advisable to use still lower frequencies, as otherwise the peripheral speed and the number of poles of the rotary transformers have to be high. An instance of this will be found in the South Dublin tramways, described in our last week's issue, where a frequency of 30 was adopted by Mr. Parshall for the three-phase power transmission work.

A Wonderful Bicycle.—There are various reasons which—other things, such as cost and weight, being equal—would lead one to prefer an electric to an oil or steam motorcart, but we never hoped to hear of anything a quarter as good as the machine to be described below. It is nothing less than an electric bicycle which will defy competition on the part of steam, oil, or any other source of power whatever. The invention, of course, comes from America, and equally, of course, is enthusiastically described in the non-technical Press — in this particular case the New York *Sunday World* is responsible — but the description has been extensively copied. It appears that the inventor, Mr. J. O'Brien, takes a wheel (American for bicycle) weighing 27lb., and adds "a battery, motor, and switchboard, which together bring the weight up to 60lb." From the illustration, the battery, which we are told is a "dry chloride" one, appears rather larger than a cigar box, and the size of the motor is not worth mentioning. With this equipment we are told that "a force can be maintained which will carry the bicycle over rough country roads, up hill and down hill, for a period of 48 hours." Only those who have seen an American "rough country road" know what this really means. In fact, "the speed of the electric bicycle is practically unlimited. It has been tested up to nearly 50 miles an hour, faster than which no one dared to try it." There is, however, power to spare, for one of the features of the machine is an electric head lamp. As, however, the light-giving power of this is stated in feet instead of candles, it is not easy to ascertain exactly how much surplus energy there is available for illuminating purposes. The inventor is an electrical engineer of experience. At any rate, "he has patented machines for preventing collisions at sea, automatic ice-boxes, scintillating signs, and nickel-in-the-slot machines. He considers the battery which operates the electric bicycle his greatest achievement." When we have seen it do all the above we shall consider so too. With every possible deference to the authority and accuracy of our New York contemporary, it would have been more satisfactory if it had been stated that some member of its staff had seen the bicycle run for half an hour or so, say, at 10 miles an hour instead of 50. At present, even with the liberal discount of 80 per cent., Mr. O'Brien's invention will have some difficulty in gaining acceptance in electrical circles.

Contacts with Tram Wires.—In the course of an article in the *Elektrotechnische Zeitschrift* of May 7 on the subject of safety appliances for preventing any injurious effect following the accidental contact between overhead tramway wires and telegraph or telephone wires, Mr. R. Ulbricht figures and describes an automatic apparatus for immediately earthing the tramwire in case of such a contact. The apparatus has been tried by Mr. Melzer, of the Zwickau tramways, and exhibited in action on that line in the presence of representatives of the Imperial German Post Office and of both the Leipzig tramway companies. The trolley wires of the up and down lines of the tramways, where they are crossed by telephone or telegraph wires, are protected by guard wires running parallel to the trolley wires and at some distance above them. In most cases of fallen wire this would be sufficient to prevent a contact, as the fallen wire would hang in bights from the guard wires and would be well clear of the trolley wires. If, however, the breakage occurred close overhead so that there was a loose end to be dealt with, this would not be the case, since the loose end would hang straight down from the guard wire to the tram wire, and if it fused there is nothing to determine at which point it would go. Moreover, under the influence of the wind or anything causing the loose end to swing, there would be the contingency of momentary contacts occurring of a very troublesome character. In the Zwickau arrangement the two guard wires are connected by a cross span wire which goes to the coil of an electromagnet and thence to the rails, constituting the return of the tramway circuit. A wire also goes from the overhead tram wire to this, the earthing wire, at some point between the electromagnet and the rails. This wire, of course, puts the trolley wire to earth, and the circuit is accordingly broken in the neighbourhood of the electromagnet. When, however, the latter is excited and attracts its armature, this latter releases a falling piece, which completes the circuit. Any slight current from the telegraph or telephone wire would be too weak to affect the armature, but even a momentary contact, which sends the heavy current of the tram wire through the short length of fallen wire to the guard wire and thence to the electromagnet, at once puts the tram wire to earth until someone comes along and replaces the falling piece. It is stated that the trials made at Zwickau proved exceedingly satisfactory.

Magnetic Testing of Iron.—In a paper read before the Institution of Civil Engineers on "The Magnetic Testing of Iron and Steel," Prof. J. A. Ewing, F.R.S., referred to the practical importance which now attaches to the magnetic testing of iron and steel in relation to the manufacture of dynamos and transformers. From being a mere laboratory experiment interesting only to students of physics it had passed into the rank of an engineering operation. In dynamo construction the introduction of permeable steel castings for the field magnets had given greater latitude as to form without loss of efficiency, the best steel castings being indeed somewhat better magnetically than most forged iron. In stampings of sheet metal for transformers the main consideration was absence of hysteresis, and so great had been the advance in this respect that iron was now readily obtainable with only half the amount of hysteresis which was considered possible a few years ago. This had brought about a notable increase in the efficiency of alternate-current distribution by reducing the large element of loss which occurred through the hysteresis of transformer cores during the hours of light load as well as of heavy load. A novel apparatus was shown in detail for measuring permeability by comparing the magnetising force required to produce a given induction with the force required to produce equal induction in a standard bar. This apparatus, which the author terms a magnetic bridge,

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from its analogy to the Wheatstone bridge for the measurement of resistance, reduced the operation of testing to a comparison between the specimen and a bar the magnetic quality of which had been determined once for all by the instrument maker. The two bars were connected by end yokes, and by varying the number of turns in the magnetising coil on one of them the yokes were brought to the same magnetic potential. The relative number of turns on the two thus gave the relative magnetising forces required to produce the same induction in both. A simple form of magnetic detector showed when the two yokes were brought to the same potential. The manipulation consisted in varying the number of turns acting on one bar by means of dial switches, while the magnetising current was from time to time reversed. This permeability tester was intended for workshop use, and might take its place alongside of the author's hysteresis tester, which was also described. The methods of directly measuring hysteresis were briefly referred to.

Vacuum Tube Lamps.—Mr. D. McFarlan Moore has been reading a paper before the American Institution of Electrical Engineers on the subject of recent developments in vacuum tube lighting. This is what is sometimes called in America—as it seems to us without any justification—"etheric" lighting. Mr. Moore's chief invention in this connection is, as is well known, the use of a make-and-break enclosed in a vacuum tube instead of one working in the open air. By this means he obtains a much sharper cut-off and avoids the effects of the arc that follows the attempt to break any considerable current in air. To obtain the maximum amount of glow in the vacuum tube Mr. Moore finds it advisable to largely increase the surface of one of the terminals, one of the forms used by him consisting of a perfect brush of loops of aluminium wire. So much has been heard lately of the cathode rays that no one will be surprised to learn that it is the negative terminal only which is enlarged and subdivided. Beyond the new forms of terminals experimented with, there is little that is novel n the paper. The question naturally asked on a matter of this kind is, What is the efficiency of the method compared with an ordinary incandescent lamp? So far as can be gathered, Mr. Moore appears to consider on theoretical grounds that the possible efficiency ought to be very high since there are few or no useless "heat" waves. This does not at all follow, for ordinary ultra-violet and Röntgen waves consume energy, but are quite as useless for lighting purposes as the infra-red "heat" waves. Practically, all we get on the subject of efficiency is contained in the following: "It is interesting to contrast the colour of the light of these tubes with that of an incandescent lamp. The reddish and wasteful glare of the latter, indicating heat waves, and the pure daylight white of the former are immediately apparent. It is this difference in colour that makes an efficiency calculation so difficult. It is very easy to ask the question, How many watts per candle-power? But in most instances it indicates a lack of information on the part of the questioner. The question should be, How many watts per amount of light equivalent to one candle-power? But even this is not perfectly correct, because it is well-nigh impossible to compare accurately lights of a different colour and power of diffusion. When the use the light is to be put to is stated, the problem is much more simple. For instance, if it is to be used to read by, the range of legibility can be made the basis of comparison between the true incandescent lamp and the candle." Until he gets something much more definite than this, even with the addition of the somewhat obvious statement that an increased illumination "can be reached by multiplying the area and length of the tubes and distributing them in the most advantageous manner," it is to be feared that the "questioner," in his lack of information, will be inclined to think that the carbon filament is not at present in much danger of being superseded by Mr. Moore's modified Geissler tube.

Medical Electricity.—An abstract of a paper on the subject of the scope and value of electricity in medicine which was read before the Medical Society of the London Hospital by Dr. W. S. Hedley has been published in the *Lancet*. Dr. Hedley had naturally something to say on the subject of Röntgen photographs, and then went on to speak of the convenience of being able to obtain a limitless supply of current from the electric lighting main. In the lead of a 16-c.p. lamp there is "an ever-ready supply of electrical energy, either of a continuous or of an alternating kind. The former furnishes a current which will do all that the uniform flow of the galvanic cell can accomplish. Passing the same current through a coil, there is obtained that dissymmetrical alternating current universally familiar as the current of the medical induction apparatus." Still availing himself of the same supply, the medical man can heat his cautery, light an exploring lamp, or charge his accumulators, or, passing the current through a motor, drive his static machine or actuate his therapeutic alternator. The latter can in its turn be arranged to supply a current having all the smoothness and other qualities of that known as sinusoidal, with its rapidity, its E.M.F., and even the shape of its E.M.F. curve under absolute control. "If the current that comes to his door in the street mains be an alternating one, he passes it through a transformer to apply it to the body to electrise his water bath or to heat his cautery. He is thus supplied with an alternating current of a symmetrical, although not of a strictly sinusoidal, character, whose therapeutic usefulness is fully proved. In that form of oscillating current known as the 'static-induced' he finds another modern current and the most efficient method of inducing powerful and painless muscular contraction. Still more recently he begins to turn his attention to those currents of great frequency and high potential whose phenomena are a revelation to the scientific mind, and whose effects open out new fields of physiological research and point to endless therapeutic possibilities." Not very long ago, when an unmeasured current was "dabbed" on to the body at the end of a couple of sponges, and it was orthodox practice to administer faradaic torture by means of a couple of metal cylinders grasped by the patient, the one end and aim of electrisation was to induce muscular contraction. This idea still survived in the popular mind, in the electricity of the "trained nurse" and of the "medical electrician." Modern practice covered a far wider field. Besides a purely localised action, nutritive, sedative, or stimulant, it was sought by methods of general electrisation, not only to influence for good the functional activity of organs, but to exercise a demonstrable, perhaps even a measurable, influence on the whole process of nutrition. After referring to the curious fact that when the frequency became exceedingly high (over 100,000 ⌒ per second), the effect of the alternating current was completely changed, so that the human body might be placed in circuit almost without the patient knowing it, Dr. Hedley concluded by speaking of the investigations of Mr. d'Arsonval on the physiological effects of such currents, which appear to be an analgesia at the point of entry and exit of the current; a fall of arterial tension; increased action of the skin; and an increase in the "respiratory combustions." This naturally led to a reference to Mr. d'Arsonval's researches on the electrical attenuation of toxines, a subject which has already been treated of in these columns.

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CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXXI.

(Specially Contributed.)

Mr. Robert Davidson constructed an electromagnetic locomotive which was tried upon the Edinburgh and Glasgow Railway in 1842. Fig. 1 shows the general arrangement. Here the fixed magnets were electro-magnets, and the rotating magnets on the large cylinders geared to the wheels were permanent magnets.

I am afraid I have wasted a little time in indicating these applications, but I do it with a purpose to show how eager in those very early days men were to apply electrical energy to industrial purposes. They failed, not because

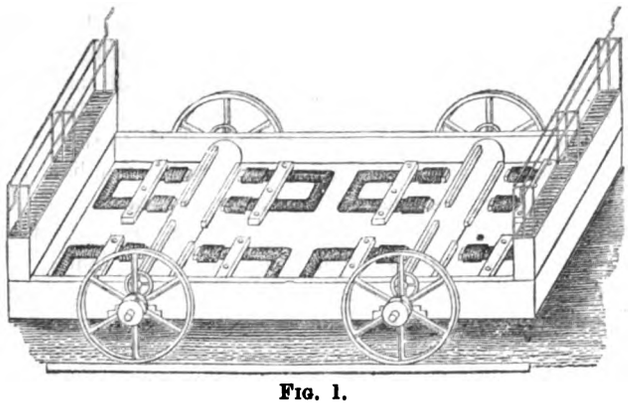

FIG. 1.

their machines were cumbrous or complicated, but because energy obtained by burning zinc in a battery was far too costly to compete against energy obtained from other sources. The application of Faraday's researches was for a time almost entirely directed towards the obtaining a means to transform electrical into mechanical energy—that is, to obtain a workable motor. The end of this period may fitly be said to have been about the time of the great exhibition of 1851. At that exhibition a medal was awarded to Mr. Hjorth, a Dane, for his motor.

Hjorth's Machine.—The diagrams (Fig. 2) show this machine in elevation and section, which, it will be seen,

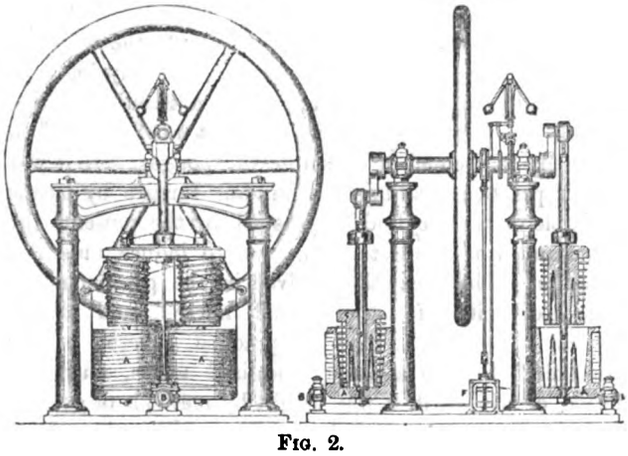

FIG. 2.

differs considerably in appearance from those previously mentioned. A A is a hollow horseshoe magnet conical on the inside, and suspended so that it oscillates on the centre, B. In the interior of this magnet is fixed a number of conical rods of different lengths. C C, above A A, is another horseshoe magnet conical on the outside, with apertures in the core corresponding to the before-mentioned conical rods. This upper magnet moves on guide rods connected together at the top by a cross-head, and fastened at the bottom of the magnet, A A. A connecting rod attached to the centre of C C drives a flywheel shaft by cranks in the usual way. A commutator, O, working like the slide-valve of a steam-engine, was used. The current to the commutator was regulated by a flywheel. The current from battery goes by commutator to coils of A A, thence to coils of C C, and back to battery. It will be seen that Soren Hjorth was attempting to fashion a motor on the lines of the steam-engine. According to the report of the exhibition, "the following table shows the attractive power" of a particular dimensioned machine:

Distance of the respective poles (inches)	The attractive force was (lbs.)
5	72
4	80
3	98
1½	140
1	160

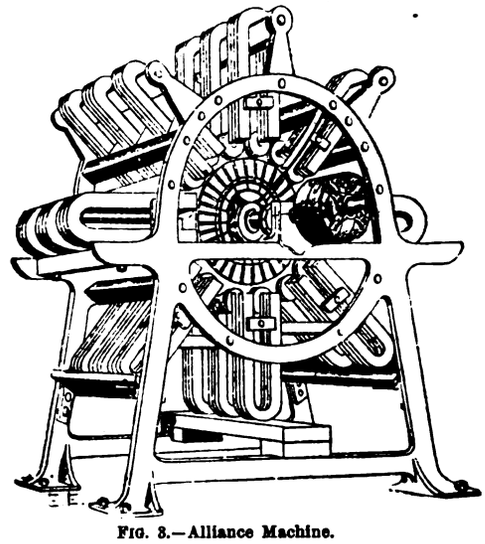

FIG. 3.—Alliance Machine.

Lighthouse Work.—From the earliest years of the century it had been known that an electric current passing between carbon points gave rise to an extremely brilliant light. Inventors were desirous of designing electric machines which would enable this light to be used in light-

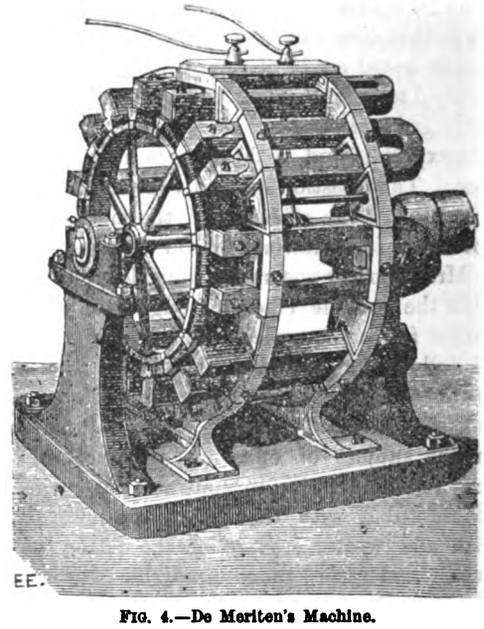

FIG. 4.—De Meriten's Machine.

house work, and ultimately they succeeded. I will direct attention to two such machines only—one almost the first designed for lighthouses, the other almost the last. Prof. Nollet, of Brussels, suggested, and the Compagnie d'Alliance, of Paris, built, magneto machines of the kind illustrated in Fig. 3. In these Alliance machines an armature rotates between eight rows of compound permanent magnets. This is merely a multiple modification of Clarke. The armature coils are double in number to the magnets, and can be connected in different ways according as greater pressure or greater current is required. Fig. 4 shows the De Meritens machine, the field of which is also made of compound permanent magnets. The armature is in shape like a wheel, on the rim of which are the coils. Fig. 5 shows the construction of the coils. Each is wound round a core of laminated soft

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iron, and fixed on the rim of the wheel, as shown. But we need spend little more time over this class of machine. They have no substantial advantages to place against their obvious disadvantages. Practically their advantages are two :

(1) The E.M.F. is proportional to the velocity of rotation ; and
(2) is independent of external excitation.

They have the enormous disadvantages—

(1) That the field density is far less when using permanent magnets than can be obtained by using electromagnets ; hence
(2) to obtain similar results from the use of permanent magnets, the machines must be very much larger than when electromagnets are used.

These considerations have led to the almost universal adoption of dynamos in engineering work, though for the

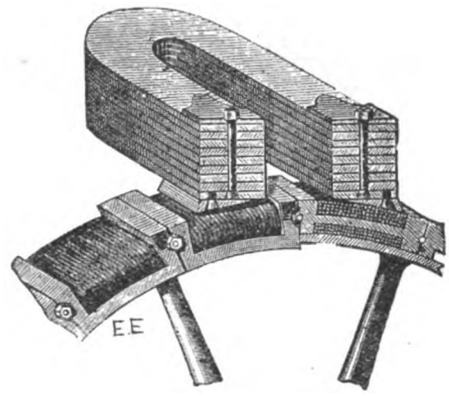

FIG. 5.—Coils and Magnet of De Meriten's Machine.

very minor but important purpose of telephonic signalling small magnetos are largely used.

EXPERIMENTAL TESTS ON THE INFLUENCE OF THE SHAPE OF THE APPLIED POTENTIAL DIFFERENCE WAVE ON THE IRON LOSSES OF TRANSFORMERS.*

BY STANLEY BEETON, C. PERCY TAYLOR (STUDENTS), AND JAMES MARK BARR.

(Concluded from page 552.)

Power Curve.—The actual mean power supplied to the transformer was determined by finding the products of corresponding instantaneous values of the applied P.D. and current. The products thus found were plotted as curves (see Figs. 2, 4, 5, 6, 7, 8, 9, and 10), which were then integrated with a planimeter and the mean ordinate determined. This then gave us the input, and, since the copper loss was negligible—being less than one-fifth of a watt—it represented with sufficient accuracy for our purpose the total watts lost in the iron core of the transformer.

EFFECTS OF THE INJECTOR.

As this paper is essentially one dealing with transformer tests, we do not propose to discuss at any length the effects obtained by the use of the injector, but it may be useful to consider one typical case of injected resistance and one of capacity. The effect of injecting rather a large resistance when the current is not in phase with the P.D. maintained between the terminals of the transformer is well illustrated by the wave shown in Fig. 7. In this test, a resistance of 36 ohms was thrown in over the first part of the wave, but, in addition, we had a capacity of 96 microfarads permanently in the main circuit, which brought the current into phase with the P.D. between the terminals of the alternator. By bringing the current into phase with the P.D. we mean that the zero readings of the two waves occurred at the same point, but the waves, of course, possessed very different shapes. The distinguishing feature of this wave is the curious sort of hump which occurs just at the beginning. The explanation of this is not hard to find. It will be observed that during the interval in which the current is opposite in sign to the P.D. the ordinates of the latter curve tend to increase, but directly the current-wave crosses the zero line the P.D. begins to decrease.

* Abstract of paper read before the Institution of Electrical Engineers, May 14.

Consider for a moment the instantaneous P.D.'s between the terminals (1) of the machine and condenser, (2) of the injector, (3) of the transformer and resistance, R, represented by v_1, v_2, v_3 (Fig. 11) respectively, during the interval just alluded to.

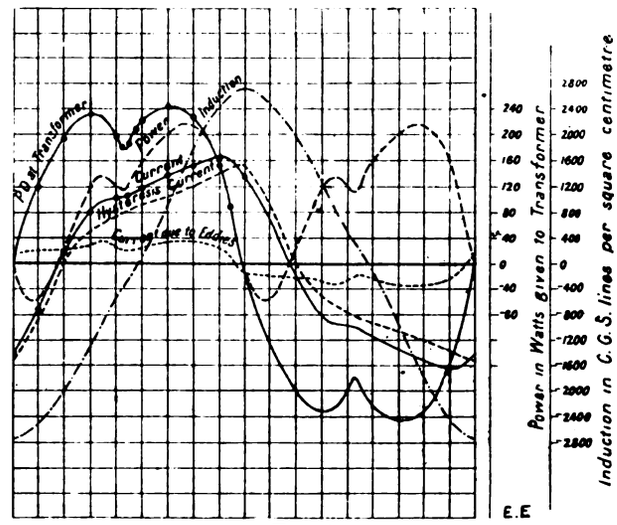

FIG. 4.

Since the current is in the opposite direction to the terminal P.D. of the transformer, we have :

$$v_1 = v_3 - v_2 ;$$
$$v_3 = v_1 + v_2 ;$$

that is to say, for this short interval the P.D. across the transformer equals the sum of the P.D.'s of the machine and the injector. This, then, fully accounts for the presence of the

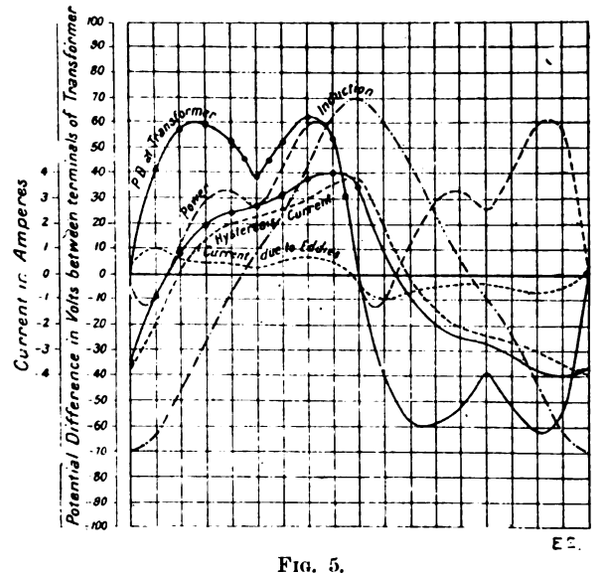

FIG. 5.

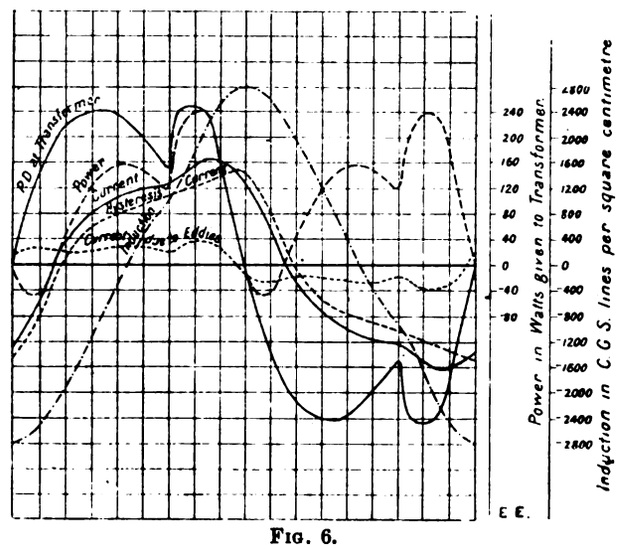

FIG. 6.

hump. The effects obtained by the injection of capacity will be best explained by a reference to Fig. 12 and Fig. 13. In the latter

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we have shown (Curve A) a P.D. wave at the terminals of the transformer and non-inductive resistance, R (Fig. 12). This was obtained by adding, at each point, the drop in pressure due to this resistance to a curve obtained at the terminals of the transformer, and shown in Fig. 5. The interval during which the condenser (60 microfarads) was in circuit is also shown in Fig. 13, and the curve of P.D. between its terminals—*i.e.*, the brushes, b_1 b_2, Fig. I.—marked B, was obtained by integrating the current-wave during this interval. By combining these two waves we get the P.D. between the terminals of the alternator, shown in Curve C. Since the condenser P.D. is obtained by integration, its maximum necessarily occurs when

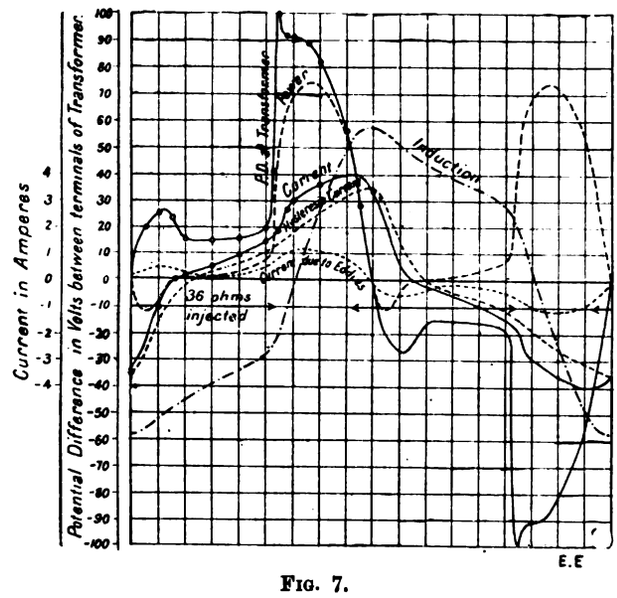

FIG. 7.

the current crosses the zero line. This maximum value is directly proportional to the area of the current-curve from the point of injection to its zero point, and inversely proportional to the capacity of the condensers injected.

On referring to Fig. 13, we note that since the current is large when the condenser is thrown into circuit, the Curve B rises very rapidly, and therefore the Curve A turns down very rapidly away from Curve C, and crosses the zero line where B and C cross each other. The maximum point of the condenser P.D. curve, of course, occurs at the same time

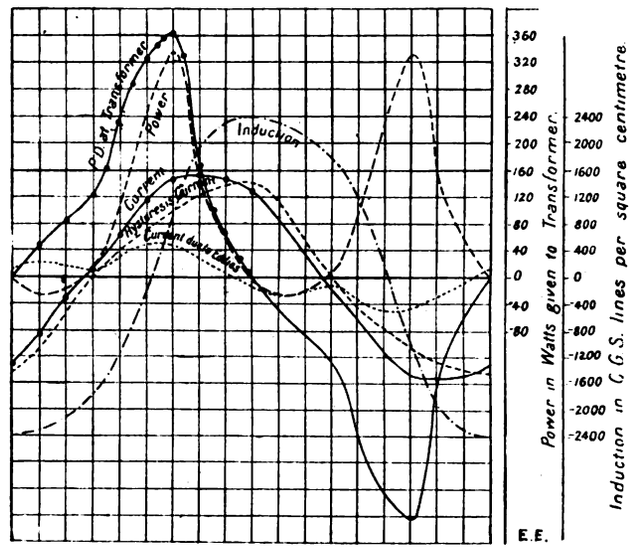

FIG. 8.

as the maximum difference between Curves A and C, and thus, when the Curve B turns down, A bends over and begins to approach C, which it crosses when B crosses the zero line. Soon after this the condenser is short-circuited, and thus B follows the zero line and A is again coincident with the alternator P.D. curve, C. This coincidence lasts as long as the condenser is cut out of circuit by the "injector." The points marked on the condenser potential difference curve, B, were obtained by experiment. They do not lie accurately on the curve, but this is probably due to slight sparking at the injector brushes, which made the electrometer readings somewhat unsteady when taking this wave. Our chief object in taking points on this curve was to set at rest any fears that might have been entertained as to the advisability of periodically throwing in and removing from a circuit a bank of condensers. It has been shown that when a circuit possessing capacity in the form of condensers is broken there may be a sudden rise of potential at the terminals of the latter. No such rise of P.D. was observed in our experiments, and this was due to the fact that the condenser circuit was never really broken, for the capacity was removed from the circuit by being short-circuited.

Discussion of Results.

Our great aim at the time of carrying out these experiments was to find some definite law connecting the iron loss in the

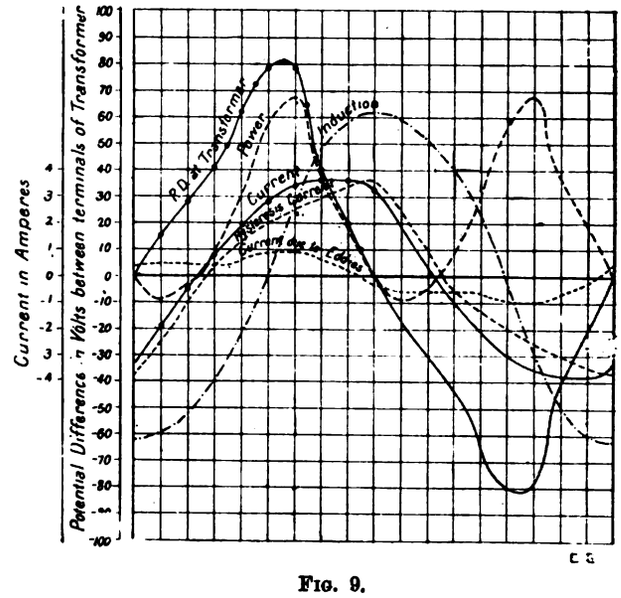

FIG. 9.

transformer with the shape of the applied P.D. wave. In no work published on the subject at that time could we find any results or conclusions which could form the basis of a connected theory regarding this question. None of the investigations on this subject had justified any conclusion which could materially help in judging of the exact, or even relative, value of wave-forms not actually tried.

The conclusions that we came to were—(1) That if the R.M.S. value of the applied P.D. is constant, and the area of the P.D. wave is constant, then, whatever be the shape of this wave, the

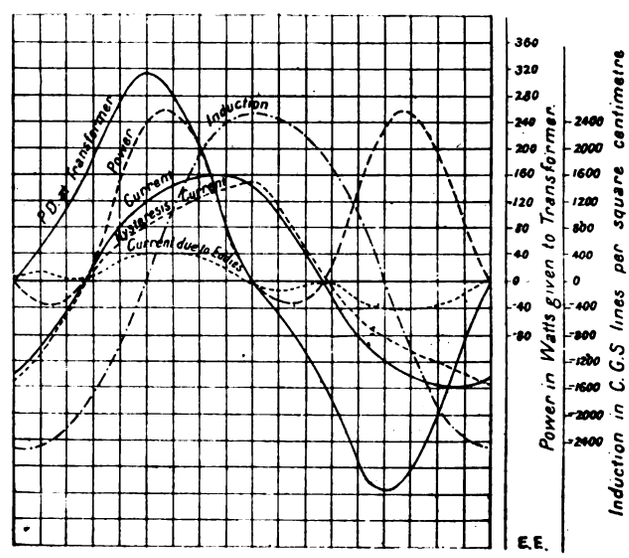

FIG. 10.

total iron loss cannot vary. (2) That if the R.M.S. value of the applied P.D. is constant, but the area of the P.D. wave varies, then, whatever be the shape of this wave, the total iron loss will vary by an amount which is only dependent upon the area of the P.D. wave. We feel fully justified in coming to these conclusions, for, as we have shown above, the hysteresis loss depends only on the area of the P.D. wave, and we have proved experimentally that the eddy-current loss is constant for a given effective P.D. This we refer to again below. The results calculated from our tests will be found in as concise a form as possible in Table I.

Hysteresis Tests.—In order to get a complete theory regarding the iron losses it was essential that we should separate those due

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to hysteresis and to eddy currents. To determine the former loss, then, hysteresis tests were made on the transformer itself by a method independently suggested and used by Prof. Ewing* and Dr. Hopkinson. We found this method most satisfactory. The two 12-turn coils of the transformer were used, one as the magnetising and the other as the test coil. A large resistance was put in series with the magnetising coil to reduce the time constant of the circuit. The magnetising current was measured by means of a standard Weston ammeter, while in series with the test coil we had an Ayrton and Mather narrow-coil ballistic galvanometer, which was standardised with one of Hibbert's magnetic standards. In this way four complete B H cycles, as shown in Fig. 14, were determined for the transformer.

They were integrated with an Amsler polar planimeter, and the results obtained were plotted to show the relation between the maximum induction and power lost in hysteresis, at a frequency of 100 ∽. The curve is shown in Fig. 15. The hysteresis loss for each test was obtained by calculating the maximum induction as previously shown, and referring to this curve, and the eddy-current loss by subtracting this from the total.

Variation of Applied P.D.—It will be observed, on reference to Table I., that the effective values of the applied potential difference are not all the same; they vary between 48 and 50

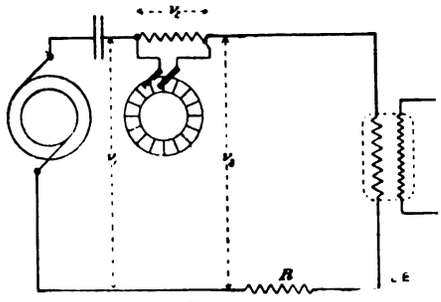

FIG. 11.

volts. This is due to the fact that they are not instrument readings, but are calculated from the curves by means of the first moment planimeter. The method of using this instrument to give the R.M.S. value of a curve was described in the articles referred to elsewhere. It was due originally to Mr. Turner, one of the demonstrators in the mathematical department of the Central Technical College. We have given preference to this method of obtaining the effective values of both P.D. and current mainly for two reasons—viz.: Firstly, far greater accuracy is attainable by this method. This is easily understood when it is remembered that, by increasing the number of water cells used in conjunction with the electrometer, this instrument could be made as sensitive as we wanted, whereas the sensibility of the voltmeter was fixed. Secondly, by calculating all results from the curves of P.D. and current, any small errors which arise from inaccurate readings or drawing appear in them all, and these are made of far less relative importance. The voltmeter, V (Fig. 1), was therefore only used to keep the effective value of the P.D. constant throughout each test, and it was not specially calibrated. This

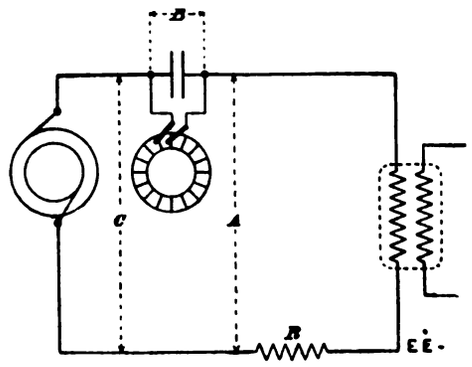

FIG. 12.

method of calculating the results has, however, introduced some difficulty in drawing conclusions from our experiments, as the small variations in effective P.D. must be taken into consideration. The difficulty of arriving at the true effect of this variation arises mainly from the fact that the eddy-current loss has been obtained by taking the difference of two much larger quantities, and thus the probable error is a large percentage of the whole range of variation. After a careful study of columns 2 and 7 of Table I., we came to the conclusion that within the limits of accuracy attainable by our experiments—*i.e.*, about

* Paper on "Magnetic Qualities of Iron," Royal Society, April, 1894.

½ per cent.—the eddy-current loss is proportional to the square of the applied P.D. This leads at once to the further conclusion that the eddy-current loss is independent of the wave-form of P.D. so long as its R.M.S. value is constant. In order that this variation of applied P.D. should not obscure the true meaning of our results, we have calculated by known laws the difference in the iron losses produced by the difference in the value of the applied P.D. from 50 volts, and thus found the iron losses for each wave shape corresponding to an applied P.D. of 50 volts. The methods of correction employed were as follows: The effect of variations in the R.M.S. value of the P.D. is most marked in the case of the eddy-current loss, so that we will deal with this first. We have, then, here corrected the eddy-current loss to a value corresponding to a common effective applied P.D. of 50 volts. In doing this, since each test is corrected separately, we only assume that so long as the

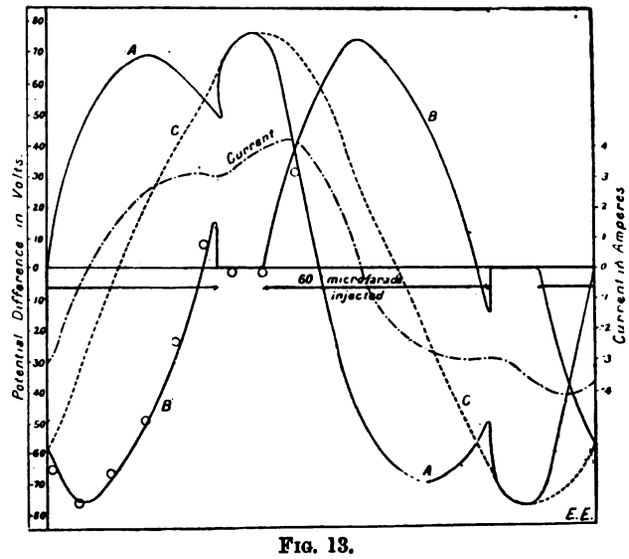

FIG. 13.

wave shape of P.D. is constant the eddy-current loss varies as the square of the effective volts.

TABLE I.—Results of Transformer Tests Calculated from Curves.

Figure.	R.M.S. or effective values. P.D. in volts.	R.M.S. or effective values. Current in amperes.	Apparent power in watts.	Iron losses in watts. Total	Iron losses in watts. Hysteresis.	Iron losses in watts. Eddy currents.	Power factor.	Maximum induction in lines per sq. cm.
3 A	49·5	2·42	120·0	92·5	60·5	32·0	0·77	2,330
3 B	49·8	2·75	137·0	95 5	63 0	32·5	0·70	2,410
3 C	48·5	2·81	136 0	93·5	65·0	28·5	0·69	2,490
3 D	48·9	2·95	144·5	97·5	66·0	31·5	0·67	2,520
4 E	49·2	3·03	149 0	103·0	71·0	32 0	0·69	2,680
4 F	48·1	2·92	140·5	104·5	74·0	30·5	0·75	2,750
4 G	49·5	2·80	138·5	111·0	76 5	34·5	0 80	2,800
4 H	48·1	2·85	137·0	106·0	76 0	30 0	0·77	2,790

TABLE II.—Results of Tests Corrected for a Common Effective P.D. of 50 Volts.

Figure.	R.M.S. or effective P.D. in volts.	Maximum induction in lines per sq. cm.	Iron losses in watts. Hysteresis.	Iron losses in watts. Eddy currents.	Iron losses in watts. Total.
3 A	50	2,350	61·0	32·5	93·5
3 B	50	2,420	63·0	32·5	95·5
3 C	50	2,560	67·0	30·0	97·0
3 D	50	2,570	67·5	33 0	100·5
4 E	50	2,720	73·0	33 0	106·0
4 F	50	2,850	79·0	33·0	112·0
4 G	50	2,830	78·0	35·0	113·0
4 H	50	2,900	82·0	32 5	114·5

From Table II. we see that, with the exception of the tests shown in Fig. 5 and Fig. 9, the eddy-current loss is practically constant; the variation of half a watt meaning only ½ per cent. in the determination of the total loss. Again, for the correction of the hysteresis loss we need only consider laws which hold so long as the wave-form is constant. Under these circumstances the area of the P.D. wave varies directly as the R.M.S. value. Now, the area gives us at once the maximum induction, and the corrected hysteresis loss is then got by a further reference to Fig. 15. The values thus obtained are given in column 4 of Table II. The corrected total loss is now

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determined by the addition of the eddy-current and hysteresis losses, from which we obtain the curve given in Fig. 16.

The Relation of the Iron Losses to the Area of the P.D. Wave.—In Fig. 16 we have shown the relation between the total power lost in the transformer and the area of the P.D. wave expressed as a percentage of the maximum area possible with the given R.M.S. value of 50 volts. It may be of interest to point out here that the ratio of the area of the P.D. wave

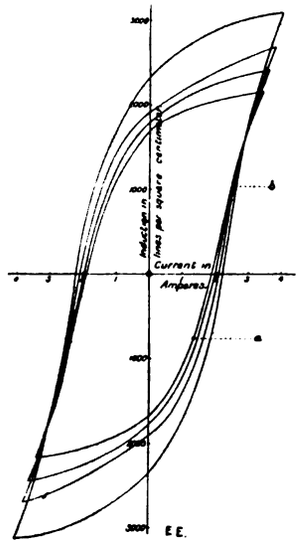

FIG. 14.

to its maximum possible value is the reciprocal of the ratio more recently called by Dr. Fleming the "form-factor." This maximum area occurs with the rectangular shape shown in Fig. 17. Such a rectangular wave would give the greatest possible value of maximum induction—in this case 3,020 lines per square centimetre. On reference to Fig. 15, it will be found that the loss due to hysteresis corresponding to this value of maximum induction would be 88 watts; adding to this the constant loss due to eddy currents—namely, 33 watts—the total power wasted in the iron comes out at 121 watts. This value must, of course, constitute the top limit of the curve shown in Fig. 16, since this wave shape has the largest area possible with the given effective value. It will be noticed that we have gone fairly close to the limit in this direction in our experiments. The process of fixing the limit in the other direction consists of finding the shape of P.D. wave which will have the smallest area for the given effective value. Now, it will be obvious that before the area of a wave of constant R.M.S. valve can be very much diminished the maximum ordinate must of necessity be increased. We cannot, therefore, diminish to any great extent the hysteresis loss without necessitating

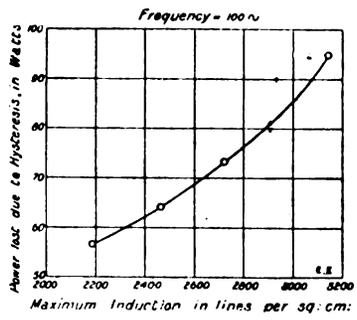

FIG. 15.—Curve showing the Relation between the Maximum Induction and Power Lost in Hysteresis in a 3-K.W. Mordey Transformer.

higher insulation. If, on account of this difficulty, the maximum ordinate of the P.D. wave must have a definite limit (*e.g.*, maximum value not to exceed twice the effective value), the shape giving the least iron loss will be that shown in Fig. 18. This is again rectangular, which may seem curious, but the essential point is to get as wide a peak as possible, and thus, as it were, confine the wave to one part of the period. This wave has been drawn to the same scale as the one given in Fig. 17. The area of the curve shown in Fig. 18 will be found to be exactly 50 per cent. of the possible maximum (Fig. 17); in fact, with waves of this type having a constant R.M.S. value, the area, and therefore the maximum induction, is inversely proportional to the maximum ordinate. This gives us a measure of the minimum possible hysteresis loss with different allowable P D. maxima. It is evident that unless the maximum ordinate of the wave is limited its area can be infinitely reduced while its R.M.S. value remains constant.

Advantages of Peaked Waves of P.D.—Our lowest iron loss is that given by the P.D. curve shown in Fig. 7. This is due to the fact that it approaches most closely to the form shown in Fig. 18, thus giving the least area, and consequently the smallest hysteresis loss. It will be observed from Table II. that there is a total variation of 22½ per cent. in the total iron losses. The consequent economy of using peaked waves of P.D. of course becomes especially noticeable at low loads, but even at full load the saving thus effected is by no means insignificant. For let us assume that the efficiency of a transformer worked off the P.D. wave shown in Fig. 6 is 95 per cent. at full load, then, if the iron loss is, say, 2½ per cent. of the maximum output, we would increase the efficiency

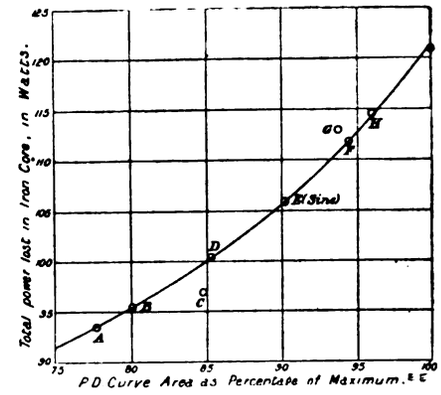

FIG. 16.—Curve showing Relation between the Total Power Lost in the Iron Core of a Transformer, and the Area of the Applied Potential Difference Wave expressed as Percentage of the Maximum Area possible with a R.M.S. value of 50 Volts. The letters A to H refer to the curves given in Figs. 2, 4, 5, 6, 7, 8, 9, 10.

of the transformer to over 95½ per cent. by using the P.D. wave shown in Fig. 9. Under circumstances of cheap power production this saving may not be of extreme importance, but in systems of distribution or transmission of power where large transformers are used, the efficiency of transformation is not the only question to be considered. One of the chief difficulties in designing large transformers is the providing of adequate means for keeping them cool, and any means by which the necessity for special cooling arrangements can be materially reduced will be sure to commend itself to those who have to deal with large transformers.

No-Load Current.

We have not been able to arrive at any satisfactory explanation of the variation of the no-load current with the shape of the applied P.D. wave. The curve given in Fig. 19, however, is interesting as showing that the maximum current occurs with the sine wave of P.D. The power factor for this wave (Fig. 2) is also the smallest (Table I.). This is a distinct point against the use of sine waves of P.D. with transformers, especially in cases where many transformers have to be kept magnetised on

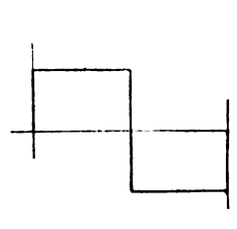

FIG. 17.—Type of the Least Efficient Wave of P.D. Maximum Value = Effective Value.

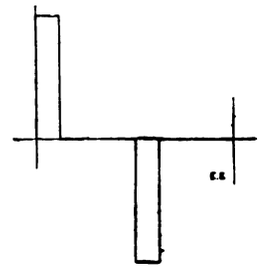

FIG. 18.—Type of the Most Efficient Wave of P.D. when the Maximum Value = 2 × Effective Value. (Same scale and effective value as in Fig. 17.)

light secondary load at the end of long mains; in cases such as these, the mains losses—which vary as the square of the current—form a very appreciable item of the whole loss. The difference between the R.M.S. currents in Fig. 7 and Fig. 2, for instance, is 25 per cent., so that the main losses in Fig. 2 would be more than 50 per cent. greater than in Fig. 7.

In order to arrive at a satisfactory explanation of the shapes of the current waves, they must be considered as built up of two components—a hysteresis component and an eddy-current component. We have split them up in this way in Figs. 4 to 10; the hysteresis component was obtained from the induction curve by means of the B H curves in Fig. 14, and the eddy current by taking the difference between this and the total current curve. It will be at once apparent that the peculiarities of the current curves are due almost entirely to the eddy-current component; the hysteresis parts are all very similar in shape. The roundness of the curves, especially

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noticeable in Figs. 8, 9, and 10, is entirely due to the eddy currents, the hysteresis component being in all cases comparatively flat on both sides. The eddy-current components have been obtained by a somewhat complex method, and a discussion on the details of each one is therefore hardly justifiable; but as a class they exhibit some very interesting features, the most notable of which is that the curves are very nearly in phase with the P.D. waves. Speaking generally, the curves also have shapes similar to the P.D. waves. This is a clear indication of the fact that the eddy currents may be considered as equivalent to one current flowing in a supposed secondary circuit. It follows from this that the eddy currents have the effect of bringing the total primary current curve more nearly into phase with the P.D. wave, and thus tend to increase the power factor. It will be noticed that in all the curves, with the exception of Fig. 2, the eddy-current component leads

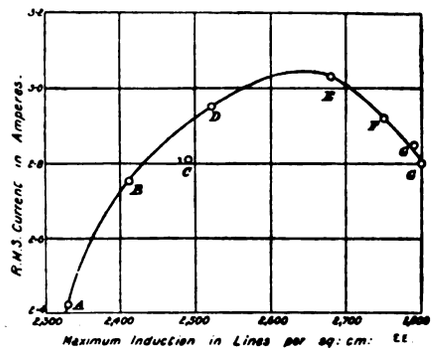


FIG. 19.—Curve showing the Relation between Maximum Induction and R.M.S. Current in a 3-K.W. Mordey Transformer. (From Table I.)

slightly in front of the P.D. wave; it is, however, so slight that it needs some corroboration from other experiments. The only explanation possible seems to be that the plates of the core, being separated by insulating paper, form a condenser, thus causing a small capacity current as well as the ordinary eddy currents.

NOTES ON INVESTIGATION BY DR. ROESSLER.

The conclusions at which we arrived in August were partly anticipated, we found, by Dr. Roessler in a paper read in Germany in July, 1895, but not published in England until November. Dr. Roessler, however, since he could only experiment with two wave-forms of applied P.D., could not prove by experiments the results which he obtained theoretically. Dr. Roessler's system of measurement differs very materially from ours. To obtain the power given to the transformer Dr. Roessler employed the usual form of dynamometer-wattmeter, with its necessary corrections, and this gave rise to some rather complex calculations with the different currents. Dr. Roessler treats the question very largely from a mathematical standpoint,

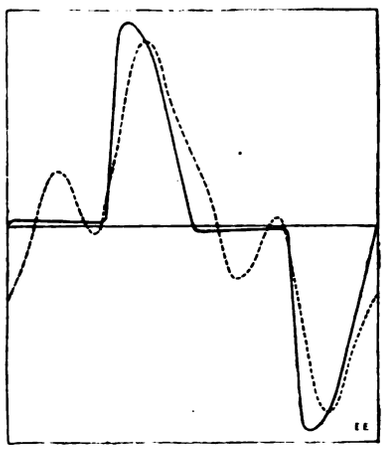


FIG. 20.—The Continuous Line Curve shows Wave actually Produced with Injector. The Dotted Line Curve shows Wave that would be produced by combining the First Three Odd Harmonics.

and introduces a correcting factor into his formulæ for each typical wave-shape; but he does not appear to have fully appreciated the fact that the whole question of hysteresis loss is wrapt up in the area of the applied P.D. wave, independently of the R.M.S. value. In this paper we have shown that it is this area alone which determines the hysteresis loss of a transformer. Dr. Roessler makes some interesting comments on the equation,

$$E p_1 = J_1 \omega_1 + 0{\cdot}4\pi \frac{n_1^2}{l} S \frac{d B}{d H} \frac{d J_1}{d t},$$

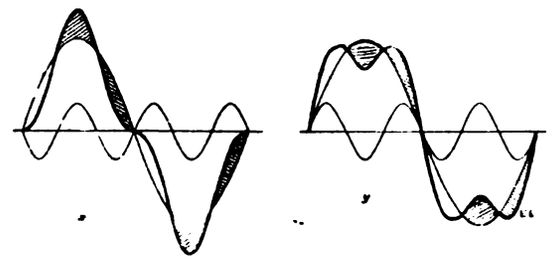
in which E p_1 = primary P.D., J = primary current (both instantaneous values), n = primary turns, and l and S are respectively the length and cross-section of the path of the lines in the iron.

The following sentence occurs: "If . . . the alternator gives a very pointed potential curve, and very high maximum value, the maximum value of $\frac{d B}{d H}\frac{d J_1}{d t}$ must be very great. *But* $\frac{d B}{d H}$ *is independent of the alternate-current curve*" [the italics are ours], "and only depends on the hysteresis curve; hence the value of $\frac{d J_1}{d t}$, which is simultaneous with the maximum value of the potential curve, must be greater with pointed curves than with flat." This is not necessarily so, and the reason is this—that the value of $\frac{d B}{d H}$ is dependent on the form of the P.D. curve in so much as it is dependent on the point on the hysteresis cycle at which we are working, and this, again, on the part of the period at which the maximum value of P.D. occurs. Compare Figs. 7 and 8. In Fig. 7, when the P.D. is at its maximum, the induction curve has not crossed the zero line, and we are working at the point marked "*a*," Fig. 14; but when the P.D. is a maximum in Fig. 8 we are working at the point "*b*," Fig. 14: the value of $\frac{d B}{d H}$ at *b* is 70 per cent. greater than at *a*, and this is why the current curve is so steep at the time of maximum P.D. in Fig. 7 and comparatively flat in Fig. 8, although the maximum P.D.'s in these two only differ by 10 per cent. The steepness of the curve in Fig. 7 is also partly due to the eddy currents. In conclusion, we wish to thank both Prof. Ayrton and Mr. Mather for their kindness and help throughout these experiments; and we are especially grateful to Prof. Ayrton for the assistance he has rendered us in the preparation of this paper.

APPENDIX.

Before deciding on the method described in this paper for obtaining potential difference waves of any desired shapes, we considered the practicability of using a series of alternators coupled on one shaft. By this means various component harmonics differing in phase, amplitude, and frequency could be produced and combined to give any desired wave-shape. This idea of combining harmonics to obtain prescribed results has been known for some time. Lord Kelvin used it in his famous tide-predictor, and it was afterwards employed by Profs. Ayrton and Perry in 1877 in their apparatus described in a paper on "The Music of Colour and Visible Motion."* Although this method would have been in some ways very convenient, we were obliged to dismiss it as too expensive. It is also difficult to get waves of very great irregularity by this method. Dr. Fleming, in reference to this method, remarked that three such alternators, giving frequencies in the ratio 1, 3, 5, would be sufficient for the majority of curves met with in practice. We were anxious, however, to experiment with waves not actually met with in practice, since our aim was not so much to find out which alternator now on the market was the best, but rather to give some information if possible which might be a guide in the future design of alternators for use on transformers.

On considering the question more fully, we also find that the first three odd harmonics given by the series of alternators just mentioned would not, in many cases of not very distorted waves, give a close approximation to the true shape; thus, we find that in order to get a peak in one part of a wave, it is necessary to cause the rest of the period to consist of a



Third Harmonic in anti-phase. Third Harmonic in co-phase.
FIG. 21.

series of irregular undulations. We cannot, in fact, by this method alter one part of the wave without getting into difficulties with the rest of it. This point is brought out very clearly in Fig. 20. Here we show a wave which we have produced by our method of "injection," and also the wave given by the combination of its first three odd harmonics (dotted curve). It will be noticed that though this wave approaches the desired shape at the peaked part, it is far from it during the rest of the period. The harmonics for this wave were obtained with one of Coradi's harmonic analysers, by the courtesy of Prof. Henrici. It is here that our method

* Physical Society, November 23, 1878.

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has one of its chief advantages. If we want a peak or a depression in one part of our wave, we make it, and leave the rest in peace. The injector method is also one which may be adopted at very little cost. It may be argued that the condensers are expensive, but they are not necessary, as a great variety of waves can be got by injecting resistance and using more than one pair of brushes (b_1, b_2, Fig. 1), and so getting more than one injection on each half-wave. It should also be remembered that when using condensers the greatest effect is got with the least capacity. The effect of higher harmonics on the area of a P.D. wave (and consequently on the maximum induction) cannot be stated generally; but it may be of interest to indicate the general principles on which it rests. To do this, a simple case may be taken as an example. It is only necessary to consider odd harmonics, as even ones makes the waves unsymmetrical about the time line.

Consider the case of a third harmonic superimposed on a fundamental sine wave, as shown in Fig. 21. The amplitude of the harmonic is here three-tenths of that of the fundamental.* The two extreme cases are shown—namely, those with the harmonic in co- and anti- phase. The effective value of the resultant is the same in each case—viz., very nearly 4 per cent. greater than that of the fundamental—but in x the area of the semi-wave is diminished by that of a half period of the harmonic, and in z it is increased by the same amount; this is the maximum effect possible, since, whatever the relative phases be, two of the half periods of the harmonic cancel as regards area. The area of the wave may therefore be diminished or increased by 10 per cent. by the addition of the harmonic. The area of a sine wave of the same effective value as the resultants will be 4 per cent. greater than that of the original fundamental. Thus, by building up a wave of two harmonics such as here chosen, we may get resultants of constant effective value having areas from 6 per cent. greater to 13·5 per cent. less than that of the sine wave of that effective value. It will be apparent from this reasoning that the effect of harmonics is entirely dependent on their phase relatively to the fundamental, and that attempts such as were made at the time of the "Sine Wave Controversy" to state generally the effect of harmonics in the P.D. wave on the iron loss of a transformer are quite futile.

Discussion.

The paper was read for the joint authors by **Mr. C. Percy Taylor**, and in order to allow time for discussion portions of it were either summarised or omitted, while for convenience of demonstration other parts were transposed. Among the omitted parts was the note on Dr. Roessler's investigations. It will be seen that this was not without its effect on the discussion, but had any other course been adopted the latter must necessarily have been most seriously curtailed.

The first speaker was **Prof. Fleming**, who wished to correct some opinions which had been attributed to him in the paper. He (Prof. Fleming) would also like to make the criticism that the authors had not done enough justice to Dr. Roessler's work. Six months ago Dr. Roessler had described experiments which practically covered the whole of the conclusions the authors had arrived at. Dr. Roessler pointed out distinctly that the loss in transformers depended on the relation between the R.M.S. value and the true mean value, and the conclusions of the authors were only another way of saying the same thing. As his hearers all knew, he himself had found it convenient in this connection to define and use the term "form factor." Everyone knew before that the form of the curve had a good deal to do with the core loss in transformers, and that a peaked curve gave the least loss. The authors seemed to imply in the paper that he (Prof. Fleming) had thought that the sine curve gave the greatest loss. He knew very well it did nothing of the sort. He had only pointed out that machines with a sine curve did not give the least loss as at one time some had supposed. Again, the authors seemed to minimise the value of experiments made with actual machines in an endeavour to find the best alternator. Now, there was no best alternator outside of the manufacturer's catalogue. Each type had its own advantages. In order to improve any apparatus surely the first step was to know what the present form of it could achieve, and therefore the first thing to do in an investigation of this sort was to analyse the performance of existing well-known machines. That was what Dr. Roessler had done with two well-known machines, and he (Prof. Fleming) had done the same thing with the Ferranti, the Mordey, and the Thomson-Houston machines. Everyone was well aware that good design was really a compromise, and the adoption of one firm or another was really a question of the end in view. It had been well understood for a long time that a peaked curve gave a smaller loss than some other forms, and if he were asked to do so any manufacturer would give you a machine with a curve as sharp as a serpent's tooth. But then the secondary drop would be increased and the maximum value would be increased. In the City of London station, for instance, there were two machines which gave the same R.M.S. value, but which had a difference of 1,000 volts in their maximum values. To carry things to an extreme, there could be no particular advantage in designing and using a machine that would break down half the cables every time it was switched on. His own feeling was that a great deal could not be done in the direction of altering the curve. They could diminish hysteresis loss by giving a peaked form to the curve, but they would in doing so introduce other difficulties. Again, it was a common idea that any given alternating current machine had a fixed wave-form of its own. That was not the case—the wave-form depended on the load carried and on the armature reaction. There was nothing to be gained by the discovery that an extravagant form of curve would have unusual advantages in the way of smaller core loss. He thought that there was much more to be gained by studying the transformer than by confining their attention to the ideal curve form. What was badly wanted at the present time was the discovery of some means of reducing the increase in the loss in transformers that went on with time. There was no doubt, however, that in the mechanism described the authors had provided a means of arbitrarily varying the form of the wave. There was, nevertheless, no question that with the wave-forms which were met with in practice the first three terms (the odd harmonics) were enough to build up the curve while they were not enough when the wave-form was extreme. If the authors had been able to make curves which had different form factors, but the same R.M.S. value, it would have been interesting to have seen whether the form-factor was strictly proportional to the loss or merely increased with it. If the authors, with the appliances at their command, had done this, they would have added to the knowledge of the subject.

Mr. Rhodes remarked that, with relation to what Dr. Fleming had said, the subject might be attacked from a theoretical point of view. The transformers being on open secondary circuit, the potential difference between the terminals might be considered the same as the back E.M.F. Then, writing down the equation for the induced E.M.F., Mr. Rhodes ultimately arrived at a result that the iron loss depended on the area of the P.D. curves and not on their form, provided the virtual value of the P.D. is kept constant. With regard to the problem of making this loss as small as possible, though it had been said that it was not a practical one, he thought there might be cases in which it would be advisable to have the iron losses as small as possible, and therefore to know how to minimise them. If, however, they attempted to work out the problem by making $\int V\,dt$ a minimum, keeping $\int V^2\,dt$ constant, it would be found that there was no absolute minimum value unless the maximum P.D. was limited. If, however, the maximum P.D. was limited, there was a limiting value.

Mr. Evershed said he had come to the conclusion that it would not be advantageous to design machines which should differ very much from those at present in use, but that that was so did not in the least detract from the value of the experiments carried out by the authors of the paper. The theory of the alternating-current machine had been wrapped up in mystery and entangled with the sine wave, and Dr. Fleming had been responsible for much of that. Consequently, experiments of the kind carried out by the authors were very desirable. What was wanted to be known was the answer to the question, "How many units am I going to save if I alter all my machinery?" There were central stations in London which delivered three or four million units per annum. Assuming the transformers were banked, it remained to consider what could be the possible saving. Taking the figures in the paper as to the difference in the iron losses with different wave-forms, it would be found that if for the existing machines giving approximately sine waves some machine which gave a better form of wave—say some form approaching that given in Fig. 12 of the paper—the maximum saving appeared to be 10 per cent. of the 2½ per cent., which was the loss in the iron. On 4,000,000 units that gave a saving of 10,000 units. Those units saved, however, could not be charged at the selling price per unit, because all that was really saved was the coal required to generate them and a little oil and waste. If they put that at 1d. per unit there would be a maximum saving of 10,000 pennies, or less than £42 per annum. He did not think that anyone would propose to change his machinery to effect this. He did not imagine that the authors of the paper intended to say, "That is the best form, and we think alternator builders now should build like that." What they said was, "If you build like this, so-and-so will happen." The mechanical difficulties in the construction of the machine and the question of vibration might turn out of more importance than the actual form of the wave. Without explaining his reasons, he thought the authors would agree with him that the eddy-current wave ought to be of exactly the same shape as the P.D. wave, and where that was not the case he thought errors of observation or calculation ought to be looked for. Also they had become accustomed to use the term "effective current," and he wished to enter a protest against dropping it in favour of "root mean square." Lastly, he wished to congratulate the authors on the experimental skill with which they had carried out their difficult investigation.

Mr. Tremlett Carter considered that, in spite of what had been said, the subject discussed was a very practical one, and he could have wished it to have been possible to have had some American engineers take part in it. In America alternator builders were advertising alternators with different wave-forms for different purposes. Curiously enough, they offered a flat-topped wave for transformer work which the authors had proved to be the worst form, and advised a true sine wave for long-distance work, their claim being that the absence of harmonics prevented line losses. The form of wave must be determined by what the transformer had to do, and when it was known what the iron losses were it was possible to select the form wanted. After referring to what had been brought out at the Physical Society as to the effect of the arc on the form of an alternator wave, Mr. Carter complimented the

* Unless the ratio of the maximum of the fundamental to the maximum of the harmonic is greater than the ratio of their wave-lengths, the curve will dip below the zero line at the ends of the half period, in cases such as shown in x, Fig. 21.

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authors on the ingenuity with which they had devised the apparatus with which they had obtained their results.

The **Chairman** (Prof. Ayrton) was sorry to see Dr. Fleming had left. He (Prof. Ayrton) was not fond of asking people to take a retrograde step, but he must ask them to go back a year and consider what was the published knowledge on the subject treated of in May last. What was not published knowledge was a different matter, but as far as the authors could know, Dr. Fleming's views then were those quoted in the paper — namely, that the iron core loss was greatest in alternators with a sine curve. It was therefore a fair conclusion of the authors to assume that it was supposed that if the sine wave was the worst a very flat-topped wave would be better. Alternators with the same R.M.S. might have a very different maximum, and going in this direction it was possible to have a flat-topped wave and a very safe machine, and it might be expected from Dr. Fleming's published conclusion that such a wave would be more efficient than a sine wave. The authors, however, found it was little good going in that direction, as a flat-topped wave was the worst form of wave to use. It was not a fact that the sine wave was the worst form. The authors had shown that if you go up (a peaked wave and high maximum) you get danger and efficiency, and if you go down (flat wave and low maximum) you get safety and less efficiency. So far as efficiency is concerned, the sine wave is neither very good, nor very bad. Though that part of the paper had not been read, the researches of Dr. Roessler had not been slurred over, and the authors of the paper had communicated to him (Prof. Ayrton), and, doubtless, to their associates, the conclusions they had come to from their experiments before they had heard of Dr. Roessler's investigations. If it was asked why they had not published their own results several months ago, he was afraid he must confess that it was his (the speaker's) fault. He had persuaded the authors not to publish their results in a weekly journal, but in a paper before the Institution. They all knew the course affairs had taken during the past session. The first meeting could not be held. There had been long debates on house wiring and other matters, and it had only now become possible to bring the paper before the Institution. With reference to their very ingenious instrument, the "injector," in a laboratory where many people were working together, an idea might be transferred from the older to the younger man. But in this case it was not so. The idea was absolutely their own, and he quite agreed that the authors' instrument was at the same time a valuable and an economical one. The great advantage of the instrument was that, instead of wobbling about with harmonics, as some people had done, the authors could produce just the curve they wanted, and, moreover, do it in the same direct way that anyone would draw a curve in practice. If anyone wanted to draw an arbitrary curve, say the profile of a face, he would get the forehead right by itself and then the nose right and then the chin right, and not try to produce it all at once by wobbling about a set of harmonics, and in getting the nose and chin right spoil the forehead. He (Prof. Ayrton) thought the authors were much to be congratulated on their paper, and he did not think that after the way in which Mr. Taylor had read it, his audience would suspect that he had been confined to his bed from illness and had only been able to leave his room two days before.

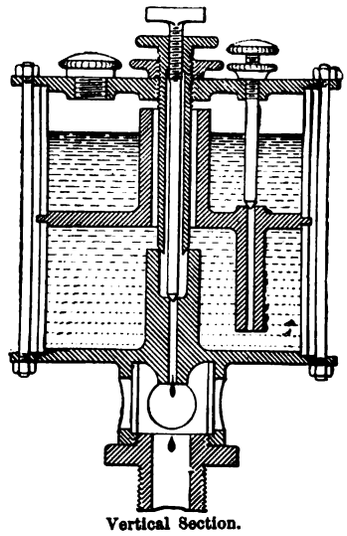
Mr. J. M. Barr replied for the joint authors. The main criticism that had been directed against their paper had been entirely disposed of by what had been said by Prof. Ayrton, and he himself, therefore, would say nothing at all upon that point. With regard, however, to the question of building up a curve with harmonics, the authors thought they had said very plainly that the advantage they claimed for their method over that of harmonics was that if they wanted, say, to take a piece out of curve, they simply took it out at once without in any way upsetting the form of the rest of the curve. He would like, however, to say that no emphasis should be laid upon the fact that they had desired to go outside those wave-forms which were given by alternators in practice. What the authors felt was that the experimenter, working with the machines in practical use, had been beset by the difficulty that using machines giving the same R.M.S. value he did not get very great differences in true area or wave-form. Consequently there was a danger that the differences which he found might be due to, or at any rate not easily distinguished from, merely experimental errors. In order to establish the complete validity of a law, it was necessary to show that it applied to forms that were more extreme than those met with in practice. What the authors had wanted to do, therefore, was to supplement what had been already done with forms of waves met with in practice by seeing how far what seemed to be the conclusions from that work held good when the peculiarities of those waves were exaggerated, and so to render it certain that a given effect was the necessary consequence of any particular form. If, then, they found that they got better and better results as their waves got more and more peaked and worse and worse results the more the wave was flattened, they had shown that the conclusion of the efficiency of a peaked wave was a real one and not merely apparent. That form was therefore desirable so far as the use of it did not lead to other disadvantages. Dr. Fleming had said that it was not true that every alternator had a wave-form of its own, because the wave-form changed with the load. But he had not said that the change was more or less in the direction of a sine wave, and that with a sine-wave machine there was very little change in wave-form as a result of varying the load. As a matter of fact, the authors had found that the wave-form of most existing machines was a very rigid affair, and that a radical method had to be adopted if it was desired to cut out a portion of the wave.

Mr. Taylor added that Dr. Fleming had argued that the wave-form was a very small matter in central-station practice. That might be so; still, he thought it must be an advantage to know exactly all the conditions involved, since unless you knew all the conditions you could not design a central station to the best advantage. He (Mr. Taylor) was not in agreement with Mr. Rhodes in thinking that the eddy-current loss depended on the maximum induction, but upon the mean value of $\left(\frac{dB}{dt}\right)^2$, that is, on the square of the effective P.D.

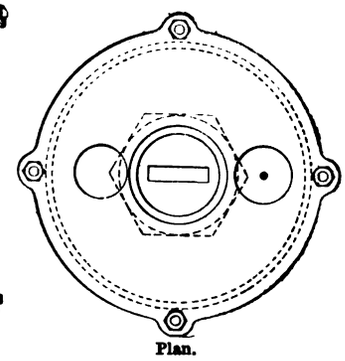
The next and final meeting of the session is on May 28.

NEW SIGHT-FEED LUBRICATOR.

The accompanying illustrations will show the design of a self-filtering sight-feed lubricator which has been brought out by Messrs. Boswell and Carter, of 1, Vere-street, Eccles New-road, Salford. The figures give a vertical section and plan of the lubricator, and it will be seen from them that there are two glass-bodied chambers with a division plate between them. The oil is poured into the upper chamber, from which it flows through an adjustable pilot valve down a tube to the bottom of the lower chamber, the pure and lighter oil rising and passing down centre tubes and past the adjustable and stop valves, and is



Vertical Section.



Plan.

seen dropping through the lantern nipple. The heavier oil or any deposit remains on the bottom of the lower chamber, while any glutinous matter or air bubbles adhere to the sides of downward tube and bottom. If the flow of oil through the pilot valve is interfered with, the reserve of oil from top of centre tube to under side of division plate is drawn upon, and as this oil is used a line of light is seen in the lower chamber below the division plate. Air is admitted to lower chamber through sleeve of regulator-valve spindle, and lubricator can be emptied by simply inverting it. The stop-valve can be closed without interfering with regulator-valve.

THE VALUE OF EXPERT EVIDENCE.

The current that flows in a go-ahead way,
  The current that wriggles about;
The current, *drehstrom*, as the German folk say—
  Oh! which is least open to doubt?

  Go, ask it of Crompton; of Mordey enquire;
    And post it to Nikola T.;
  But their varied opinions will make you perspire
    If you seek for the best of the three.

The engine that drives by the aid of a zone;
  The engine that drives 'em direct;
The engine whose flywheel's not wholly its own—
  Which one have we most to respect?

  Go, ask it of Hammond; ask Charterhouse-square;
    Let Kennedy utter his mind;
  But the varied opinions will cause you to swear
    If you're wishful a moral to find.

The copper that's covered with lead and with jute;
  The copper with papery megs.;
The copper that's clad in a waterproof suit—
  Which, which is the rottenest eggs?

  Go, ask it of Siemens; go, ask it of Gay;
    Ask Nisbett his view of the case;
  But you might as well go to the top Himalay,
  If you've any more questions like these on the way,
    And ask them of infinite space!

J. H. C. B.

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THE

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THOSE COMPANIES.

Our interest in electrical progress is too great to permit, without grave consideration, our suggesting even caution to investors. It is, then, with qualms that we direct attention to two companies which have been extensively advertised during the week. We have stated before, and we state again, our emphatic protest against all company promoters who foist their wares upon the public without the technical Press having a chance to discuss the value of the goods proposed to be bought and sold. The electrical promoter who has anything good to get rid of has no fear of adverse criticism from the electrical journals. What we all fear is the bringing into the market goods that will not bear expert examination. Now, let us examine the prospectuses of these two companies—the one to put upon the market electric omnibuses; the other, electric mining lamps. Everyone will admit at once the desirability of such vehicles and lamps. With regard to omnibuses, and, indeed, for almost all horseless vehicles, we think that electrical is the only form of energy that can in the long run bear the test of trial. The stink of oil or gas in the crowded streets of our cities would be an intolerable nuisance. Electricity has everything to recommend it except cost. We are speaking only of self-contained vehicles. For many years we have advocated the use of such vehicles, and hoped to have seen progress developed in this way. Gentlemen to whom the cost would be less than that of horse traction could obtain elegantly-designed and light carriages to be driven by accumulators. With such carriages there would be every advantage for the accumulators. An examination of our volumes will show that years ago we expressed an inclination towards direct-current distribution from central stations, and we still believe that alternate-current distribution has, in many instances where chemical action is required, tended against the development of the electrical industry rather than for it. If it were possible to charge accumulators in the stables of every gentleman who keeps horses and who has the house lighted electrically, we believe the getting rid of legislative disabilities would lead to a large number of electrically-driven carriages being used. The advocates of alternate-current distribution have been able to think of one thing, and one thing only—the return at the moment. Let there be no mistake in this matter. We are no thick-and-thin advocates for direct current—we know that each case must be judged upon its merits; but we also know that each case has not hitherto been so judged. The users of accumulators for traction purposes commenced with the worst extreme, and demanded perfection under the most adverse circumstances, coming to the conclusion that accumulators were not worth anything for traction. That was not fair to accumulator makers. In fact, they have never had a fair chance, and we are exceedingly doubtful if the expectation of the promoters will at once be realised with omnibuses; but they seem to think otherwise, and recent information indicates a better state of things at Paris than has been accomplished

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in England. In our opinion, the earliest development in horseless traction will be—as it should be—with the lighter vehicles, which are not likely to work the accumulators to their fullest capacity; and experience will gradually show how to provide for the heavier vehicles and greater demands.

So far, then, as concerns traction, the present position may be summed up in a few words—horse traction is perhaps indirectly more expensive than any other form of traction. We note with some gratification that a recent leader in this paper, pointing out the probable saving to the rates by changing horse for other traction, has been extensively used by the promoters of various companies. Of all forms of traction, electrical seems the most suitable if it can be carried out at a cost approximating to that which it will have to replace. The other purely electrical company relates to a miner's lamp. This, again, is an application which has been before the public for some years. Many ingenious minds have attacked the problem, but as yet no one seems to have conquered the difficulties. So far as we can gather from the prospectus of the company just announced, there is no indication that the lamp is better or worse than several others. We have the usual expert or inexpert evidence, but we should like to know what earthly value the paid opinions of professors and doctors are on this matter. These inexperts may or may not have actually worked or seen the face of a mine on some gala day in the mine, but we are pretty positive that they have little or no knowledge of the ordinary working conditions. They may retort, "Nor have you." Here we differ; we know both the gala and the ordinary conditions, and know, too, how vastly they differ. We know, too, that other miners' lamps have worked admirably for weeks or months, and that their working has been exceptional—that is, perhaps 5 per cent. of the lamps supplied have worked and 95 per cent. failed. There is nothing in the prospectus of a definite character; but, perhaps, this is because the capital is guaranteed. What we cannot understand is, this being so, why ask the public to subscribe upon such indefinite information?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

HORSELESS STREET BILL.

SIR,—As one of the earliest workers in the horseless carriage movement, and as the only person who has had the practical experience of running a horseless vehicle upwards of 5,000 miles through the traffic of London streets, I should be glad of this opportunity of expressing, on behalf of all those interested in this immense industry which is now looming on us, our grateful acknowledgment to the Right Hon. H. Chaplin, the Government, and Lord Harris for the great attention and care, having due regard to all the interests involved, that has been taken by them in removing the obstacles that have hitherto stood in the way of horseless vehicle traffic. I do not think that this momentous epoch in this great question should be allowed to pass without also some acknowledgment of the services rendered in connection with this matter by one who has represented the London Chamber of Commerce, and has also been specially able to speak on behalf of the electrical section of the horseless carriage interest, which will have most to do with street and town traffic, as opposed to country road work. I refer to Major S. Flood Page.—Yours, etc.,

RADCLIFFE WARD.

CITY AND GUILDS OF LONDON INSTITUTE TECHNOLOGICAL EXAMINATIONS, 1896.

ELECTRIC LIGHTING AND POWER TRANSMISSION.

PRELIMINARY EXAMINATION.

Instructions.

No certificates will be given to candidates on the results of this preliminary examination, but their successes will be notified.

Candidates may take the ordinary grade without having passed the preliminary examination, or both examinations may be taken in the same year.

No candidate who has already passed in the preliminary or in either grade of this subject can present himself for the preliminary examination.

The number of the question must be placed before the answer in the worked paper.

Not more than 10 questions to be answered.

Three hours allowed for this examination:

1. Why are "killed spirits" or "spirits of salt" to be avoided in soldering electric conductors?

2. What are the good and bad points of the following materials if used as insulating materials for switches and cut-outs: wood, porcelain, slate, marble, and red vulcanised fibre?

3. Would you fasten the capping of cases with screws or nails? Give reasons. And what difference would it make if brass screws or copper nails were used instead of iron ones?

4. Suppose you have two leads going up the wall through the ceiling; and a lamp is placed near the ceiling, with the switch on the casing at a convenient height; can a two-groove casing be used for the main leads and switch connections? Give reasons.

5. Show how to join up two electric bells by a single line and an earth return, so that a person at either end can ring up at the other end without ringing his own bell.

6. Define the following terms: resistance, alloy, amalgam, polarisation, E.M.F., one ampere, one ohm, one megohm, one volt, one kilowatt.

7. How many volts are needed to send a current of 20 amperes through a conductor having 10 ohms resistance? What difference would it make in your answer if the circuit included a motor having a back E.M.F. of 450 volts?

8. Why is energy expended in bending or coiling a spring?

9. What is the operation of vulcanising? Why is vulcanised rubber so much used as an insulating material? Why is a layer of pure rubber sometimes interposed between a copper wire and the vulcanised rubber that surrounds it?

10. Under what circumstances would you select as an electromagnet (*a*) one wound with many turns of very fine wire; (*b*) one wound with few turns of thick wire; (*c*) one having its core made up of a number of stampings of sheet iron?

11. Name the chief kinds of batteries used for electric bells and for telegraphy, and the materials used in them.

12. Contrast the advantages of wood casing and of interior conduits for house wiring.

13. Why do sparks occur in ordinary electric trembling bells? How can they be prevented or reduced?

14. How many (electric) horse-power are needed to drive a dynamo supplying 120 16-candle lamps, if the lamps take half an ampere each, and are supplied at 120 volts?

15. What is the use of the shunt coil in an arc lamp? Why is it difficult with some types of arc lamp to work them, two in series, from mains at 100 volts?

16. Show by a sketch or sketches how to make and insulate a T-joint between a $^{7}/_{16}$ conductor and a $^{7}/_{22}$ branch conductor.

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17. You are directed to run wires for an arc lamp. What thickness of wire would you use, and why? If the wire was for 10 arc lamps in series, what difference would you make in the thickness of the wire, and in its insulation?

18. You are given 16 cells, each having an internal resistance of one ohm. How would you connect them up so as to get as large a current as possible through a wire of four ohms resistance? If each cell had an E.M.F. of one volt, what current would you get through the wire?

WHAT, WHEN, AND WHERE.

Institution of Electrical Engineers.

May 22, 8 p m.—At the Institution of Civil Engineers, Great George-street, Westminster. Students' meeting. Paper on "The X-Ray Photography," by H. L. Tyson-Wolff (student).

May 28, 8 p.m.—At the Institution of Civil Engineers. Ordinary meeting. Paper on "The Utilisation of Water Power, especially with a Small Fall, with some Examples of Plants for the Generation of Electrical Energy," by Alph Steiger.

Institution of Junior Engineers.

May 30, 10.30 a m.—Visit to the Fowler-Waring Cables Works, North Woolwich.

Royal Institution of Great Britain.

May 22, 9 p.m.—At Albemarle-street, Piccadilly. "Hysteresis." Prof. J. A. Ewing.

Physical Society.

May 22.—At Burlington House, "Dielectrics," by R. Appleyard. "The Field of an Elliptical Current," by J. Viriamu Jones. "An Instrument to Measure Frequency," by A. Campbell.

Liverpool Engineering Society.

May 30.—Visit to the Chorley Reservoir.

PHYSICAL EXPERIMENT IN RELATION TO ENGINEERING.*

BY DR. ALEXANDER BLACKIE WILLIAM KENNEDY, F.R.S., M.I.C.E.

(Continued from page 517.)

So far as concerns the training of the faculties of observation at the stage of which I am speaking, probably chemical experiments would serve as well as physical. In certain respects possibly they might even be better, but with this we need not now concern ourselves. An important point is, perhaps, that in their earlier stages the students should not be allowed in any way to get the notion that his experiments are more than mere rough exercises. Any standard of accuracy which he can possibly attain is comparatively a very low one, and by the nature of the case the experiments he can do must be simplified down enormously before they can be put into his hands, so that at best he is only making a rough determination of one element in an artificially simplified operation, the full conditions of which he is not even in any position to understand. The actual figures which are obtained by him can under no circumstances be regarded as having any intrinsic value; and one of the difficulties of the case is, no doubt, to persuade the student to exercise his highest degree of care in obtaining results which at the same time he is told, or knows, are of no use whatever. The engineering student, I am sorry to say, is generally a terrible utilitarian. The unhappy professor has to enter into all kinds of subterfuges to get him to take an interest in, or do any careful work at, matters which the omniscience of youth has once pronounced to be "useless." Later on, of course, he is wiser and a trifle less narrow-minded; but I suppose the stage of first-yearness is one through which all of us have to pass in one fashion or another, to the grief of our pastors and masters, and to our own later regret.

More interesting to most of us, perhaps, than this purely academic matter is the consideration of physical experiment under the last two headings which I have mentioned.

First among these comes experiment which really belongs to pure physics, but in which we engineers may claim to be as much, or even more, concerned than the physicists, although both the difficulty and the honour of the experiment must fall to them. I suggest that we are even more concerned than the workers in pure science for two reasons, of which the first is that the whole of our interest is practically concentrated on what constitutes only a small part of the boundless region open to the physicist. He can spread his affections over glass and sealing-wax, and let them roam from ice to iron. We have only one love, or at any rate never stray very far from a limited number of matters which concern what I have heard contemptuously called "technical materials." He interests himself legitimately and equally in argon and carbon, in steam and in ethyl-alcohol; he loves to extend his thermal conditions so as to get liquid air or gaseous carbon. We, on the other hand, are compelled to deal with a very small number of materials, and with these materials only in states in which we can readily obtain them. In fact, as everyone knows, nineteen-twentieths of our liquid and gas problems affect only liquid and gaseous (or vaporous) water, and only the remaining small percentage is left to be distributed between coal-gas and producer-gas, liquid carbonic acid and anhydrous ammonia, and so forth. So far as the more or less "permanent" gases are considered, our interest is throughout perhaps rather chemical than physical.

Then, again, we may claim to have a first interest in certain physical results, because of the extraordinary frequency with which we have somehow or other actually to make use of them—I mean a real live use, and not merely a use in an examination question, or in a text-book, or a lecture. Not only would our whole work become mere guess-work without the knowledge of these results, but, having this knowledge, we are compelled by the very nature of our work to make such continual use of it that probably we are much more familiar both with the figures concerned and with the phenomena which they represent, than even the men to whose magnificent accuracy and unlimited diligence we owe their original investigation and determination. I mean, of course, such results as refer to the thermal relations of water and steam, to the calorimetry of fuels generally, to many hydrodynamic problems, to most problems in elasticity and what is clumsily called the strength of materials, to frictional questions, to innumerable problems relating to electrical matters, and certainly to an enormous number of matters bearing on mechanics, which, of course, is to be considered as a branch of physics.

I feel so strongly this sense of our paramount interest in certain physical problems that I have not hesitated sometimes to resent the way in which physical writers and speakers are occasionally inclined to instruct us how to express our ideas—for example, as to mass and weight, and sundry vital matters of that kind. I really think that people who have to deal with these matters as much, as often, and as thoroughly as we have, and who are on the whole reasonably competent beings, may be assumed to know how best to manage our own affairs in these respects. Mechanics are to us the breath of our nostrils, and not a mere vehicle for examination papers, and it should be remembered that the requirements of the latter case may be very different from those of what I may venture to call "real life." I feel some satisfaction in remembering that the only fatal case of a misused "g" that I can call to mind was on the part of a physicist, whom we all admire none the less for the way in which he scolds us, but who in the very act of showing us the way we ought to use that symbol proved conclusively that all submarine cables would break by their own tension while lying on the sea-bottom! It would perhaps be hardly proper, or even safe, that I should here say anything, as I am much tempted to do, as to the vexed question of units, which from time to time seems to agitate many minds. Let me only suggest that, on the whole, it does not seem to me that the people who would be most affected by the change are at present those who are most anxious for it. In fact, admitting certainly a few notable and very distinguished exceptions, it really seems as if engineers in general were content to go on in their own way, unconscious of the terrible pitfalls and difficulties by which it is understood that they are surrounded on all hands. I quite admit, of course, that it by no means follows that the pitfalls do not exist, although I confess to being somewhat sceptical about their reality.

But having spoken so strongly of engineers as being the users of certain physical results, I must look at the other side of the matter. We engineers may have, as I urge, more interest in these matters than anyone else, but it is certainly true that we have not ourselves to thank for the determination of the results which we require, and which we make so much use of. For practically the whole of these results—results without which, as I have said, our profession would hardly exist, would at best be a mere trade instead of (as we are proud to consider it) a scientific profession—we are indebted to workers in physical science pure and simple, men without the least taint or suspicion of technical or utilitarian intent.* It would therefore ill become us engineers if we were to say

* The "James Forrest" lecture delivered before the Institution of Civil Engineers, Session 1895-1896.

* I think probably the only notable exception to be made in this matter is in regard to scientific experiments relating to strength and elasticity, some of which have been made by engineers and with a more or less definitely technical intention. But probably such men as Bauschinger, Martens, and Tetmajer are to be considered essentially as in the position of physical workers.

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or do anything which should, even in the most indirect fashion, tend to belittle the work of pure physicists, on which every day shows us more how much we are dependent. Our gratitude is so real and so deeply seated that we need not, and do not, even resent the expression of regret which has sometimes been heard from a discoverer—that what he has done should be of any use whatever!

A physical experiment such as is necessary for the determination of any one of the physical constants which we have in continual use differs very essentially from such physical experiments as we engineers have to carry out in the course of our own work. It is at once much simpler and much more difficult. It is simpler because its object is the solution of one certain problem, which has been by much care and pains isolated from all its surroundings, from all related and, so to speak, adjacent problems. The first work of the physicist, dealing with his problem, is, in fact, to find out a way of so isolating his question that its solution may give him exactly the one quantity he wishes to know and no other. Of problems of this kind I confess I speak as an outsider, but as an outsider it has been to me often a matter of the greatest interest and even wonderment to see what enormous pains a physicist takes, and must necessarily take, to make sure that he is measuring exactly the thing he wishes to measure—that thing, that whole thing, and nothing but that thing; to see also what innumerable precautions he has to take to ensure the absence of minute errors, or to find out where any such errors might occur, and whether they have occurred, and to evaluate them if they are unavoidable. I have found, too, that in such cases suggestions derived from my own experience in engineering experiment have been often received with a coldness which I am afraid was no more than they may have deserved! For, as I shall endeavour to show, the conditions under which experiments of this kind have to be made are absolutely different, both as to aim and method, from those of the experiments—more technical if not less physical—which we have to carry out for ourselves in our own work.

In a physical experiment of the second category, such as those of which I have been speaking, the primary points may be said to be, first, that the object of the experiment should be single, definite, isolated, separable, and separated from all surroundings; secondly, that it should be general in its nature, and should not relate merely to one special case; next, that as a problem it should be capable of exact determination; and, lastly, that the final result should be as nearly absolutely accurate as it is possible for any physical determination to be. Take as examples such matters as the determination of the density of steam, of the variation of the specific heat of water with change of temperature, of the calorific value of pure carbon, or of the mechanical equivalent of heat. Such problems properly stated admit each of one exact solution, one answer which is absolutely right, even in the mathematical sense of that phrase. It is the highest object of the physicist, in dealing with such a problem, to obtain the right solution. He spares no pains to obtain it; he determines each minute correction with the patience and care of a man who knows that the value of his whole work may be vitiated by a single overlooked source of error, even of the smallest magnitude. We engineers are possibly in some danger of forgetting occasionally, in view of the familiarity and matter-of-courseness of certain figures with which we have frequently to deal, that just these everyday and familiar numbers, on account of their very importance, were those which required and obtained for their determination the most careful, exhaustive, and accurate experimentation in the hands of the most experienced physicists.

After speaking in this fashion of the nature of experiments in pure physics, it may sound at first absurd, but it is nevertheless true, to say that physical experiments in the third category—the technical experiments which we engineers have so often actually to carry out—do not fall under a single one of the conditions which I have just given as characteristic of experiments in pure physics. We cannot, even under the most favourable circumstances, put before ourselves exact and isolated problems; we have much more often to deal with special than with general cases; we cannot choose problems which are capable of finally exact solution; and, therefore, lastly, we should treat the matter entirely wrongly if we attempted to obtain more than a certain limited degree of accuracy in our solution—an accuracy very limited indeed when compared with the all but mathematical accuracy with which problems in pure physics can be solved.

The conditions under which engineers have to carry out physical experiments, of course, vary very greatly. In certain simple cases they are essentially physical investigations, be it in connection with friction, with elasticity, or what not, which at first sight do not greatly differ from the experiments which I have just discussed. There is probably, however, more difference than appears at first sight, although the spirit in which both sets of experiments have to be made is the same. Take as an example the determination of the elastic modulus (or the specific extension) of a piece of steel. Probably, with very perfect instruments and with extreme care in manipulation, a value of the modulus could be obtained which should be accurate, say, within 1 in 2,000 for that particular piece of steel. But a figure so obtained would not be accurate even for other pieces of steel made at the same time, and out of the same ingot as the one experimented on; while, of course, there is no one absolute value for the modulus of elasticity of the widely-differing material of which all sorts go by the name of steel. Under such conditions—and I have chosen a particularly favourable example—it would be mere affectation, and, in addition, would be actually misleading, to claim anything like physical accuracy for our results. Indeed, I must go further and say that the truly scientific way of treating an experiment in engineering physics is to recognise from the outset its limitations as to accuracy, and to be careful not to state a final result in a form which should lead to the supposition of any greater degree of accuracy than that which the conditions of the work can actually allow.

(To be continued.)

THE NATURE OF CHEMICAL CHANGE AND THE CONDITIONS WHICH DETERMINE IT.*

BY DR. ARMSTRONG, F.R.S.

(Continued from page 520.)

In point of fact, it is necessary that the lessons taught by work such as that done by Stas should be seriously taken into consideration, and that the extraordinary experimental difficulties which such problems present should be more generally recognised. The almost child-like simplicity of faith and belief in the chemist's ability to purify which distinguish our physical colleagues is most remarkable. If we even venture to point out that the material which has been measured with such infinite pains may have scarcely merited so much attention, and thereby hint that the results therefore, perhaps, are but of slight absolute value, we are at once told, "Oh, if you will give us pure stuff we will examine it"; and they might add—but do not—"and secure the credit which will ultimately attach to the work," inasmuch as the mass of figures which they put forward impress the public, whilst the modest statement made by the chemist of the precautions which he has taken in purifying the material—work which may well require the expenditure of infinitely more knowledge and experience, thought, time, and labour than the physical measurements—cannot be appreciated by those who have not themselves taken part in such work. During the past 20 years, Fellows of our society have contributed in a remarkable manner to our knowledge of physical constants, and their work will have an abiding value, as they have taken very special precautions in selecting and purifying the substances examined; but hitherto there has been absolutely no reciprocity, physicists having remained content with a knowledge of the very first principles of chemistry. In the future there must be more effective co-operation between us. In making these remarks I do not wish to blame physicists entirely. I hold that we are ourselves largely responsible for such a condition of affairs, and that it is in no slight measure due to the unscientific manner in which our subject is taught, and especially to the manner in which it is overlain with details which obscure the logical interconnection of its parts.

To return to sulphur, an abstract account has recently been published in the *Proceedings* of the Royal Society (1894, 56, 32) of observations by Threlfall, Brearley, and Allen, on the electrical properties of *pure (sic)* sulphur—*i.e.*, sulphur from the Chance recovery process purified by distillation and exhaustion *in vacuo*. Such a process cannot be accepted as by any means an exhaustive one, and it appears almost to be a case of "love's labour lost" to apply to such material the infinite care which the authors appear to have taken in making the electrical measurements. Yet they arrive at the important conclusion that so long as a single modification be dealt with, such sulphur does not conduct while solid. A mixture of two modifications, however, does; but in view of the possibility of changes taking place during the production of the mixture—of conducting impurities being introduced or generated, it is difficult to regard this latter conclusion as established, the more so as the authors in question have found that as the temperature was raised, the conductivity of the sulphur increased slightly up to the melting point, when there was an enormous increase.

Passing to selenium, there can be little doubt that the properties attributed to this element, and especially its extraordinary behaviour on exposure to light, have been deduced from observations with very impure materials. Shelford Bidwell's recent account of his investigation of this element is full of interesting observations showing, as he says, that the conductivity of crystalline selenium appears to depend principally on the impurities which it

* Presidential address delivered before the Chemical Society.

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contains in the form of metallic selenides (*Phil. Mag.*, 1895, [5], 40, 233).

The conductivity of what is so wrongly called carbon, in the form used for electric light purposes, is well known to be also electrolytic in character, and is, therefore, most probably conditioned by the presence of salts, and not a specific property of the modification of the element present in such materials.

In the case of the metals also, on the other hand, many observations of great interest have been made, which are highly suggestive, and should serve to incite further enquiry. The electrical conductivity and, at the same time, the mechanical properties of all the highly conducting metals which fall into positions in the periodic system not far removed from that of copper are affected in a most remarkable manner by the presence of minute amounts of impurity, especially by certain non-metallic and metalloidal impurities. Owing to the very large use which is made of it in telegraphy no metal has had more attention paid to it than copper, its manufacture having been greatly improved by the introduction of electrolytic methods in place of the old dry methods. Fitzpatrick, in a report on the specific resistance of this metal, published in the "British Association Report" for 1890, gives a value which is better than that found nearly 30 years before by Matthiessen for "pure" copper in the proportion of 100 : 102·6; but my colleague, Prof. Ayrton, tells me that copper of still higher quality—viz., above 103—is now made on a large scale. It is noteworthy that Swan and Rhodin, in a paper communicated to the Royal Society in 1894 (56, 64), give a value which is not quite so low as that found by Fitzpatrick—viz., 1,563—Fitzpatrick's lowest value being 1,557. They speak of their copper as "pure," stating that it is probable that both of the specimens examined by them were "perfectly pure," and that, in fact, the limit of electrolytic purification had been reached; but this cannot have been the case. Moreover, they, as well as Fitzpatrick and all other observers, obtained different values before and after annealing, the specific resistance of the soft wire being 1,563, whilst before annealing it was 1,603—a circumstance which in itself, I venture to think, affords strong presumptive evidence against the conclusion that we are yet come into possession of practically pure copper, and for the following reasons.

E. van Aubel has observed in the case of bismuth (*Phil. Mag.*, 1889, 28, 332), that although annealing has a considerable effect when the metal is very impure, the effect becomes less and less marked as the impurities are removed, until finally the electrical resistance is scarcely altered by annealing; also, there is a considerably greater difference apparent between the values given for hard and soft copper by Matthiessen than has been found by later workers, who, presumably, have dealt with a less impure metal. Therefore, it appears not improbable that a pure material would suffer no change on annealing—that it would not require annealing, in fact.

Taking Spring's important investigation into the influence of extreme pressure into account, it appears likely that the change during wire drawing—hardening, to undo which resort is had to annealing—is in itself due to the occurrence of chemical change—that is, change in molecular composition; Barus, in particular, has advocated this view (compare *Nature*, 1890, 41, 369), and it has recently received confirmation from observations made by Unwin on the effect of repeated straining and annealing on the yield points of iron and steel (*Proceedings*, Royal Society, 1894, 57, 178). But if change in molecular state in a metal be subject to the same laws as are interactions in other cases, a pure material should not undergo change under the influence either of pressure or of heat, and therefore from this point of view also the fact that all copper hitherto examined is softened by annealing may be regarded as evidence that it has contained impurity.

The nature of the "impurity," the character of the changes which take place in such cases, form subjects of enquiry, not only interesting in themselves, but also of the highest technical importance. With regard to the former, attention may be called to a statement made by Hartley to the British Association Electrolysis Committee in 1887, pointing out that the preparation of pure copper is extremely difficult; and that such as he had had made for spectroscopic purposes, which was considered *pure*, had been found to contain as sole impurity about one hundredth thousandth part of silver, while other samples contained tellurium and bismuth. The photographed spectra were the means of detecting these foreign constituents. I quote this by way of reminder that ordinary, or even extraordinary, chemical tests are of no use in such cases. It must also not be forgotten that gases may become "occluded" during annealing, and, bearing in mind the extreme sensitiveness of copper—especially to oxygen—it would appear necessary in future enquiries to effect the annealing in a "vacuum" from which moisture, oxygen, etc., have been as far as possible removed.

As regards the character of the changes brought about in metals by admixture, we are, of course, but on the very fringe of the enquiry. It is certainly cause for congratulation that men like Roberts-Austen, Dewar (and Fleming), Heycock, and Neville, and Alder Wright—all our own Fellows—have done so much during recent years to extend our knowledge of the behaviour of metals; and we may confidently expect that, now interest is so generally reawakened in metals and alloys, we shall ere long be able to arrive at trustworthy conclusions.

Recent observations on the depression of the freezing points of metals seem to show that, in most cases, the liquid metal consists of monatomic molecules—in itself a very noteworthy conclusion, when it is remembered that the very opposite is true of liquefied non-metals. Whether on solidification, and as cooling takes place, these fundamental molecules form complex groups, is a question which is now being warmly debated, but is a very difficult one to decide: the view advocated by Matthiessen—I am inclined to think with true prescience—that many metals are capable of existing in allotropic modifications—that is to say, in modern language, that they may exist of different degrees of molecular complexity, is at the present time but little approved of, there being a tendency to substitute for it more purely mechanical conceptions. Only in the case of iron is it fairly generally admitted that the facts are such as to make the acceptance of Matthiessen's view almost compulsory. Osmond—whose work is of extraordinary interest and of the highest value—indeed has argued that this metal may exist in no fewer than three allotropic forms.

In the case of a pure metal, consisting in the fused state of monatomic molecules, it is conceivable that when solidification takes place interatomic forces come into action in such a manner and so uniformly that the mass, as it were, forms one huge complex molecule. This could scarcely happen if impurities were present; but in that case similarly constituted smaller complexes—individual crystals—might form. The observations of Behrens on the microscopic structure of alloys of silver and copper are perhaps of significance from this point of view, showing as they do that, whilst the crystals are scarcely distinguishable in "pure" copper, in copper containing only a minute proportion of silver they become distinctly visible, and are seen to be separated by a film of white alloy.

It is difficult to resist the conclusion that the properties even of congeries of such crystal molecules as are above referred to are not somewhat different from those of the simple fundamental molecules *en masse*. Silver, copper, and gold, it is well known, are possessed of high electrical conductivity, especially silver and copper, which are all but alike in this respect; and yet, as Matthiessen has shown, when any two of them are mixed, the conductivity of the mixture is lower to an extraordinary extent than that of either alone. That such an effect should be produced is very remarkable, and it is difficult to understand how it can be brought about by the mere admixture of molecules which apparently are equally effective conductors; this behaviour would seem, indeed, to be an indication either that the molecular state of the metal is changed, and that, in fact, it is converted into a modification possessed of lower conductivity; or that a compound of the two metals of lower conductivity is formed and becomes interposed between the highly conducting crystals.

The remarkable behaviour of silver towards oxygen also serves to suggest that the silver atoms combine on solidification. The fact that this metal is a solvent specifically of oxygen, and not of gases generally, is in a measure evidence that combination takes place between it and the gas; and on this assumption the well-known spitting may be explained as due to the occurrence of an interaction conditioned by the superior affinity of silver to silver outweighing that of silver to oxygen in the manner indicated by such an equation as $xAgO_2 = Agx + xO_2$. But this explanation does not necessitate the conclusion that the silver atoms combine otherwise than throughout the whole mass.

The evidence that one metal may combine with another is now so entirely beyond question that it is no longer open to doubt that like metallic atoms may combine. The eminently plastic character of some highly purified metals—*e.g.*, copper, gold, silver, iron, platinum—would, I imagine, lead us to prefer the view that they consist of relatively simple, if not of monatomic molecules. Whilst, on the other hand, the extraordinary brittleness produced on adding small proportions of certain elements to some of these metals is perhaps best explained by the assumption that such additions cause the formation of complex molecules having but little tendency to cohere. Such a conclusion is almost necessary in the case of iron, in which, as is well known, extraordinary alterations may be produced by altering the distribution of the impurities, without altering their amount—I allude to the passage of carbon from the combined into the free state during the rapid cooling of steel, and to the change in the opposite direction which takes place during slow cooling. Iron, indeed, is one of the most remarkable among metals, and there is no literature more deserving of the chemist's attention than that relating to the researches of Roberts-Austen, Barus, Hopkinson, Osmond, and others who, during recent years, have contributed in a most important manner to our knowledge of the changes going on in iron and steel.

Osmond assumes that even "pure" iron alters in molecular

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composition as it cools, basing this conclusion on the observation that the electro-deposited metal exhibited the phenomenon of recalescence—but the conclusion that such iron is, to use Roberts-Austen's expression, "as pure as any iron can be" may fairly be called in question, especially as Osmond speaks of it as containing a little carbon (0·08 per cent., *Iron and Steel Institute*, 1890, i., 38), and it may be doubted whether any such change would take place in pure iron. In presence of carbon, it would seem that when the temperature has fallen sufficiently molecules which are more complex than those existing at the higher temperature are formed, heat being liberated, thus giving rise to recalescence; the extent to which such complexes are formed largely depending on the amount and character of the impurity present. Perhaps it is from these complex molecules that the peculiar magnetic properties of steel are derived. The separation of carbon from iron may well take place at the moment when the complexes are formed, and the change which occurs at its separation may be of the character of that referred to above in connection with the spitting of silver. The carbide which is produced during slow cooling may conceivably be generated by the interaction of the complex molecular form of iron with the carbon. The explanation of the changes here discussed, advanced by Osmond, involving as it does the assumption that at high temperatures iron consists of the hard modification which unless prevented passes into the soft modification on cooling, seems to me to be less natural and likely than the foregoing.

It is to be hoped that ere long methods will be devised of preparing considerable quantities of iron in a state closely approaching to that of purity, so that the individual influence of various foreign substances may be studied. At present we do not seem to be aware whether the presence of carbon especially is essential to hardening, and whether this element alone can condition the state which renders steel capable of becoming permanently magnetic. Sufficient will have been said, I trust, to emphasise the extraordinary importance of attention being paid to the behaviour of highly purified substances. Enough is known to warrant the assumption that in many cases such investigations will show that properties associated with individual substances are wrongly regarded as specific, and that in reality they are determined by an admixture. To give but one more illustration, if conduction in solids other than metals be always electrolytic conduction, conditioned by the presence of composite electrolytes, a condenser such as a Leyden jar may be regarded as a voltaic cell in which the electrolyte is a solid of high resistance, and its action as dependent on polarisation; the difference between such a cell and one containing a fluid electrolyte arising from the fact that in the latter polarisation cannot be maintained except at the electrodes, whilst in the former the polarisation extends throughout the electrolyte. On this assumption it should be impossible to form a condenser from a pure substance. I venture to point this out as showing the great importance of experiments being instituted with very highly purified dielectrics.

The more our attention is directed to the important part which impurities play in determining change, whether it be in metals, non-metals, or compounds, the more necessary is it to enquire into the possible mechanism by which such change is brought about. So long as we are entirely unaware of the nature of chemical affinity and of the manner in which it is exerted, little progress can be made; there can scarcely be a doubt, however, that what has been termed residual affinity is largely operative, as, indeed, Faraday foresaw. The following remarkable passage in his fifth series of researches (§ 523) is almost as clear a statement of this view as could be given at the present day: "The theory which I have ventured to put forth (almost) requires an admission that in a compound body capable of electro-chemical decomposition the elementary particles have a mutual relation to, and influence upon, each other, extending beyond those with which they are immediately combined. Thus, in water, a particle of hydrogen in combination with oxygen is considered as not altogether indifferent to other particles of oxygen, although they are combined with other particles of hydrogen; but to have an affinity of attraction towards them, which, though it does not at all approach in force, under ordinary circumstances, to that by which it is combined with its own particle, can, under the electric influence, exerted in a definite direction, be made even to surpass it. This general relation of particles already in combination to other particles with which they are not combined is sufficiently distinct in numerous results of a purely chemical character . . . and it probably has a direct relation to, and connection with, attraction of aggregation both in solids and fluids. It is a remarkable circumstance that in gases and vapours, where the attraction of aggregation ceases, there likewise the decomposing powers of electricity apparently cease, and there also the chemical action of quantity is no longer evident. It seems not unlikely that the inability to suffer decomposition in these cases may be dependent upon the absence of that mutual attractive relation of the particles which is the cause of aggregation."

(To be continued.)

HUDDERSFIELD.

The Corporation of Huddersfield have just issued their electric supply accounts for the year ended December 31, 1895. We give below the revenue account and balance-sheet, together with the statement of electricity generated, sold, etc.:

Dr. Expenditure.				£	s.	d.
Coal, or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£541	18	1			
Oil, waste, water, and engine-room stores	48	4	5			
Wages at generating station	625	16	6			
Repairs and maintenance as follows: buildings, £39. 17s.; engines, boilers, £67. 10s. 5d.; dynamos, exciters, transformers, motors, etc., £14. 11s. 10d.; other machinery, instruments and tools, £83. 8s. 5d.	205	7	8			
				1,421	6	8
Wages, etc., to linesmen, fitters, labourers	61	0	3			
Repairs, maintenance, and renewals of mains of all classes, including materials, and laying the same	31	7	7			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of materials and lamps sold, as *per contra*	52	18	2			
				145	6	0
Attending and repairs				60	12	5
Rents payable	44	12	7			
Rates and taxes	284	16	10			
				329	9	5
Salaries—viz., engineer's department	445	0	0			
Accountant and clerical staff	199	19	0			
Stationery, printing, and advertising	59	2	2			
General establishment charges	174	18	9			
				878	19	11
Insurances, etc.				6	6	0
Total expenditure				2,842	0	5
Amount carried to net revenue account				2,474	4	7
Bad debts written off in excess of amount brought from last account, £2. 13s. 7d.; balance carried to next account to provide for bad debts, £32. 6s. 5d.				35	0	0
				£5,351	5	0

Cr. Income.	£	s.	d.
By electric supply—Sale of current per meter at 6d. per B.T.U.	4,713	18	8
Sale of current per meter at 4d. per B.T.U.	12	7	4
Sale of current per meter at 2½d. per B.T.U	5	16	2
Sale under contract	143	0	0
Public lighting	180	0	0
	5,055	2	2
Rental of meters and other apparatus on consumers' premises, £218. 1s. 1d.; sale and repairs of arc or incandescent lamps and repairs of other apparatus, £78. 1s. 9d.	296	2	10
	£5,351	5	0

BALANCE-SHEET.

Liabilities.	£	s.	d
Capital account—amount received	49,500	0	0
Sundry creditors	4,088	3	3
	£53,588	3	3

Assets.	£	s.	d.
Capital account—amount expended for works	49,079	6	2
Stores on hand at Dec. 31, 1895: coal, £2 12s. 6d.; oils, waste, etc., £9. 19s. 6d; general, £94. 5s. 4d.	106	17	4
Sundry debtors for current supplied to Dec. 31, 1895	2,855	18	3
Other debtors	162	17	6
Revenue account, balance at debit thereof	1,373	4	0
Cash in hand (engineer)	10	0	0
	£53,588	3	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			342,692
Quantity sold: Public lamps	6,760		
Quantity sold: By contract	14,669		227,753
Quantity sold: Private consumers by meter	206,324		
Quantity used on works			10,047
Total quantity accounted for			237,800
Quantity not accounted for			104,892
Number of public lamps			4
Total maximum supply demanded (B.T.U.)			308

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ON THE USE AND ECONOMIES OF RECTIFIERS FOR ARC LIGHTING.*

BY JOHN HESKETH, MEMBER OF COUNCIL.

The first practical use of electrical energy for lighting purposes was by means of arc lamps, and this method still remains to-day the most economical means of lighting possible in the present state of our knowledge. It is only reasonable, therefore, to expect that the theory and practice of arc lighting, and the knowledge of the arc lamp with its accessories and special plant, should be the most fully developed and perfected of all our electrical knowledge. But such, unfortunately, is not the case. Of all the existing systems of arc lighting, whether public or private, scarcely one exists in which some glaring inefficiency does not appear. The fact that we have all known of this lamentable condition of affairs for many years in a dim, uncertain way has perhaps hardened our hearts, and made us condone a technical sin sanctioned by common consent. Perhaps, too, the fact that, until recently, arc lighting has not been very largely adopted in England has influenced our views; the result from whatever cause has been that, speaking broadly, the thought and care given to machines, systems, and schemes for incandescent lighting has not been extended, except in a half-hearted way to arc lighting. In England arc lighting has been a side show, and incandescent lighting the main purpose of electricity works; and even in America, where in many stations the order is reversed, the inefficiencies still exist, but, it is only fair to admit, in a greatly reduced degree.

It is not with any intention to discuss the whole of this problem that the present paper is undertaken, but only to detail recent experiences in the use of one special form of apparatus and system of generating the necessary energy. The question of distribution and utilisation of such energy in arc lighting is sufficiently wide to form matter for papers for a complete session. In special reference to the subject of this paper, it is interesting to note that the first arc lamps used in French lighthouses were supplied from alternators fitted with commutators, and so were virtually rectified current arc lamps. In the earliest installation of public arc lighting plant in England, of which I think Blackpool was the first example, the practice was to run each lamp from a separate machine, so that in such a station one or more engines running on to a counter-shafting drove the dynamos and exciters, each dynamo feeding its own arc lamp though a separate lead and a common uninsulated and buried return. That such a system of generation was most inefficient is very apparent. The system of distribution and utilisation of light was perhaps equally so, and it was not long before the system, not only of distribution, but of generation, was altered completely. Installation of arcs connected in series and run from special machines, such as Brush or Thomson-Houston, began to appear, and although the machines were admittedly inefficient, and in their ordinary sizes have not been much improved, they still continue to be most generally in use. We are aware that recently the efficiencies obtained in America by the use of 50 to 55 kilowatt Brush dynamos (100 to 110 arc machines) has risen considerably above any known in England, but the conditions of practice there are widely different from those in England. The need for a public supply of incandescent lighting led in one or two instances to the expedient of running incandescent lamps in series with arc lamps from Brush machines, but as the demand for private lighting increased much more rapidly than that for public lighting, separate machines and systems gradually were adopted, and the question of generation for series arc lighting was allowed to lapse for a while. But recently the fact has been recognised that two different types of generating plant being allowed to exist in one building for purposes which could very well be fulfilled by one was most illogical and inefficient, and has resulted in a reopening of the question. This is assisted by the fact that the arc lamp is at last being recognised as the only rational means of public lighting, and its use is therefore being very rapidly extended. On continuous-current supply systems, the problem of arc lighting is not difficult of solution. The ordinary network has its coefficient of service increased by connecting the public lighting to it, but in alternating-current supplies the case is different. The alternating-current arc lamp is not so efficient as a generator of light as the continuous-current arc. The reasoning of Prof. Forbes in his recent Cantor lectures to the contrary is very interesting, but, as it is in direct conflict with the results of all experiments hitherto made, we are bound to confess that in the present state of our knowledge the alternate-current arc is not so efficient for public lighting as the continuous-current. The examples of public lighting by alternate-current arcs which have been recently carried out in various places may be excellent in themselves, but comparatively their efficiency is not equal to that of continuous-current arcs.

This is so far as we at present know. The investigations being carried out by so many authorities on this subject may result in the discovery of a more rational proportion between current strength and size of carbon or other factor which may influence the luminous efficiency, but for the present we will discuss matters as they are. The blue tinge of the alternating arc is an objection which may be got over by colouring during diffusion or alteration in the constitution of the carbons. Among the possible solutions are the following: (*a*) alternate-current arcs, with a separate transformer for each lamp; (*b*) arcs three in series off 100-volt network or separate transformer for three arcs; (*c*) any number of arcs in series off an alternate-current transformer giving varying voltage and constant current and delivering alternate currents into the lamps; (*d*) as in *c*, but with commutator or rectifier in the secondary circuit, so that pulsating currents are delivered into the lamps.

But the inefficiency of the alternating-current arc will veto the adoption of the solutions *a*, *b*, or *c*, unless the efficiency of one generating plant over two is so great as to justify the consequent loss in utilisation. The fact that the two first systems have been practically adopted, and the third suggested, is evidence of the feeling that an advantage is to be gained by having only one type of generating plant. All these reasons speak with even greater force in favour of the solution *c*, for in addition to every economy gained by systems using only one type of generating plant, it possesses the great advantage of giving arc lamps having a photometric curve very approximately equal to that of an ordinary continuous-current arc. Having gone thus far into the reasons for the adoption of a rectifier, it may be well to describe the apparatus and discuss the various points arising from its use.

Description of a Rectifier for Arc Lighting.—The rectifier consists of two points—a constant-current transformer and a synchronous motor on which is fixed the rectifier commutator. A transformer, with switches for regulating the secondary voltage, drives the synchronous motor. The two primary coils are fixed on to the horizontal limb of the iron circuit. The four secondary coils are movable, and on either side of the fixed primaries. Counterpoises are fixed to the suspending rods of the movable coils so that the repulsion between the primary and secondary is just balanced when the normal current is given out by the secondary—any increase tends to make the movable coils widen out and a decrease allows them to close together again. The net result is that the varying current at constant pressure, which is sent into the primary, is transformed into a constant current at varying voltage in the secondary. But this current is still alternating; so it is led to the commutator fixed on the end of the motor shaft. The brushes are adjustable by hand, and are so set that the current is commuted when it is at zero. As has already been stated, this shape of current is quite suitable for arc lamps, and allows them to derive all the advantage of continuous currents, while the uniformity of plant in the generating station is maintained. The most natural divisions into which a consideration of the uses of the rectifier falls are (1) efficiency of rectifier, *per se*, both apparent and real; (2) influence of rectifier on the total efficiency when used in conjunction with private lighting plant; (3) effect of rectified currents on arc lamps and other points in the practical use of rectifiers and miscellaneous notes. In considering this question the comparative figures are necessarily taken from Blackpool station, where Brush machines, rectifiers, and alternating arcs, on both simple parallel three-wire and three-in-series systems, are in use. The figures may vary with each particular case, but the broad principle is unchanged.

Efficiency of Rectifier.—The apparent efficiency of a rectifier is of almost as much importance as its real efficiency, for if the power factor be low, the apparent current being high prevents the generating plant being used at its highest capacity, for it is the current density in the armature which, almost always, is the measure of a safe load on any machine. It is therefore highly important that the power factor of a rectifier should be high. This is, unfortunately, opposed to the attainment of a very high percentage of regulation, for it is equally important that with a varying load from, say 10 per cent. to full load, the current should remain sensibly constant, and this result can only be obtained by a certain loss in efficiency. However, in the more recent types of rectifier, an apparent efficiency of 90 per cent. and a true efficiency of 95 per cent. is obtained with good regulation between one-tenth load and full load. The results with the earlier types were not so satisfactory on account of greater attention being paid to regulation than to efficiency, but seeing that on public lighting circuits the load ought never to fall below 50 per cent. of full load, there is no necessity for good regulation below that point except in the case of a blow over on to the secondary commutator, but even in this case the regulation need only be such as to prevent damage to the windings through overheating or fusion of the brushes.

Influence of Rectifier on the Total Efficiency of a Lighting Plant. — For a modern steam alternator an efficiency $\frac{\text{E.H.P.} \times 100}{\text{I.H.P.}}$ of 85 per cent. is unusually high. And as the efficiency of the rectifier complete is 90 per cent., it follows that the efficiency $\frac{\text{energy in lamps} \times 100}{\text{I.H.P.}}$ is equal

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to 95 per cent. of 85 per cent. = 80·75. This is looking at it in its barest and least favourable light. If we compare the efficiency of an alternate-current plant and rectifier with a Brush or Thomson-Houston plant, the comparison is still more favourable. The following are results of tests of a Brush 55-lighter set at Blackpool under ordinary working conditions: The engine was a horizontal compound engine by Fowler and Co.; cylinders, 9in. and 14in. by 16in. stroke; speed, 150. The dynamo was a Brush 8 L machine. Tracings of the indicator cards are annexed hereto. For this type of engine they do not show any abnormal characteristics, excepting the want of balance between the high and low pressure cylinders. This, however, would not affect the efficiency to any great extent.

TABLE I.

Date.	No. of card.	H.-P. M.E.P.	H.-P. I.H.P.	L.-P. M.E.P.	L.-P. I.H.P.	Total I.H.P.	Volts.	Amperes.	E.H.P.	E.H.P. × 100 / I.H.P.
July 25	1	53·62	40·560	12·2	22·579	63·199	2300	9 9	30·522	48·34
—	2	54·75	41·410	12·45	23 042	64·452	2300	9·9	30 522	47 35
—	3	55·00	41 600	12·58	22·299	64 899	2300	10·0	30·831	47·507
—	4	55·50	41·979	12·45	23·042	65·021	2300	9·8	30 214	46·469
—	5	53·57	40·518	12·58	23·299	63·817	2300	9 8	30 214	47·346
—	6	55·05	41·637	12·77	23·635	65·272	2300	10·0	30 831	47·235

Mean efficiency 47·37 per cent., as against 80·75 per cent. for rectifier and alternator. I am quite aware that the results are low. Indeed, they have been exceeded at Blackpool, where the same plant when new gave slightly better results. The difference, however, was not more than 5 per cent. The efficiency of some American plants using larger sizes of Brush machines is as high as 75 per cent. But this is exceptional. But the comparison is by no means ended here. As already indicated, 55-lighter (30-kilowatt) arc machines are about the largest generally in use in England, and such a dynamo rope-driven from an ordinary engine takes up a floor space of about 500 square feet. This is leaving a space 2ft. wide round the plant for attendance. Such a plant direct-driven would take up only 220 square feet, or 16 and 7 square feet per kilowatt respectively. A modern 300-kilowatt steam alternator would occupy 500 square feet, or 1·6 per kilowatt. If space for 300 kilowatts of rectifiers be included, this will add 200 square feet to the last figure and make the gross space per kilowatt 2·3 square feet. The importance of this point is most apparent. The fact that a power equal to 10 55-lighters can be generated by one steam alternator and attended to by one man is another. So far the arguments have been confined to those in favour of rectifiers *versus* other types of machines for series arc lighting only. The next point worthy of consideration is that, the load of the rectifier being dealt with by the energy lighting plant, its efficiency should really be $\frac{\text{energy in arcs}}{\text{added energy in engines}}$. For example, suppose a station to have a load of 200 kilowatts and to have 100 kilowatts in rectifiers added. The true measure of the efficiency should be, not $\frac{300\ \text{K.W.}}{\text{I.H.P.}}$, but $\frac{300\ \text{K.W.} - 200\ \text{K.W.}}{\text{I.H.P.}_2 - \text{I.H.P.}_1}$, where I.H.P._1 is the indicated horse-power to drive the ordinary load, and I.H.P._2 to drive the combined loads. Table annexed gives indicator cards taken from 200-kilowatt plant when driving, first, ordinary load; second, ordinary load with rectifier added.

Effect of Rectified Currents on Arc Lamps.—Rectified currents, when sent through circuits having self-induction, produce effects intermediate between those observed with direct and alternating currents. To observe the extent of this effect the following experiment was carried out with the results tabulated. A measured current was sent through a choking coil, and the voltage at the terminals of the coil noted. With a current of 9·52 amperes flowing, the voltage at the terminals of the impedance coil were:

For continuous current from a Brush machine ..... 5·76 volts.
For alternating currents 83 ⌒ per second from an E.C.C. alternator ..... 83·0 volts.
For the above currents rectified ..... 57·5 volts.

It therefore follows that in arc lamps intended for use with rectified currents main cores should be laminated and the bobbins split. It is not necessary that this be done for the shunt coils. The "pull" on the core is rather less and more sluggish than with a continuous current, so that a fresh adjustment requires to be made. The lamps are also perceptibly longer in "striking" than with continuous currents. The illumination from a rectified arc lamp is not perceptibly different from that of a continuous-current arc. For photometric curves of any reliability to be made requires more elaborate apparatus than is generally found in an electric supply works, but I append hereto the results of trials up to date.

Effect of Rectified Current Series Arc Lighting Circuits on Telephones.—There is an undoubted influence on telephone circuits when rectified currents are used in series circuits as generally arranged. The means for the prevention of such interference are peculiar to each case; but, speaking generally, they are such as apply to the prevention of interference of one telephone line upon another—that is, perfect electrical balance on the circuit and perfect insulation.

Maintenance of Rectifier.—The apparently heavy sparking at the brushes of a rectifier is not so damaging to the commutator as might be imagined; with care the commutator will last quite as long as those of other types of arc lighting machines. Care has to be exercised in the set of the brushes, both on the low-tension or motor end and on the high-tension or rectified end. The influence of the method of driving the alternator on the motor is very perceptible—with one machine the motor current is as steadily low as possible, while with a small machine, lightly loaded, on which the ropes jump, the motor current has to be set fairly high if steady running has to be obtained. The danger from the use of a rectifier for currents at such high tension which has been mentioned by one or two people, has not shown itself in practical use with us. The maintenance of the apparatus has been a matter of much greater ease and economy than of any other arc lighting plant in the station. This is not difficult to understand, as only two coils are movable, and these need not move more than 6in. a day. Excellent insulation is obtained, and altogether there is every facility for easy maintenance.

Conclusion.—It is with the hope that a discussion on the various systems of generation for arc lighting may be opened that this paper has been prepared. It is undoubted that there are more inefficiencies in our present arc lighting systems than in any other branch of electrical engineering; and the most lively satisfaction of the writer will be experienced if a closer investigation into all the details of this most important branch is provoked.

THE PHYSICAL SOCIETY.

At the ordinary meeting of May 8, Captain Abney, president, in the chair,

Messrs. Frith and **Rogers** read a paper on **"The True Resistance of the Electric Arc."** It was pointed out by Prof. Ayrton, at the British Association meeting at Ipswich, that if the "true resistance" of an arc was defined as the ratio of a small increase of the P.D. between the carbons to the corresponding change in the current, then it follows that this "true resistance" must be a negative quantity. In order to measure the "true resistance" without appreciably altering the form of the carbons, etc., the authors superpose a small alternating current on the main continuous current. The arc lamp employed was adjusted by hand, and the arc length was measured by projecting an image of the arc by means of a lens. The main (continuous) current and P.D. were measured by a Weston ammeter and voltmeter, while the auxiliary alternating current was measured by means of an air transformer and an electrostatic voltmeter. The authors found that between the limits employed the magnitude of the alternating current did not influence the results obtained for the resistance of the arc. The frequency, so long as it lay between the limits 250-7 complete alternations per second, and the wave-form did not influence the resistance, since the same results were obtained with a Pyke and Harris alternator, a Ferranti alternator, a Gramme alternator, and a Mordey transformer. For each make of carbon examined four combinations were used: + cored, - cored; + cored, - solid; + solid, - cored; + solid, - solid. The general character of the curves obtained was that for the + solid, - solid combination the "true resistance" was always negative, while for + cored, - cored it was always positive, the other curves being between these two extremes, those which had the + carbon solid always being more negative than those which had the + carbon cored. In the case of the curves showing, for solid carbons, the relation between the resistance of the arc and the P.D. between the carbons, the current being constant (10 amperes), a minimum—*i.e.*, a maximum negative—value for the resistance occurred at about 55 volts. With combinations having a cored positive this minimum became more strongly marked, and occurred at a lower voltage. The authors found that for cored carbons the position of this minimum was closely connected with the presence or absence of the dark space in the arc. For points on the curve to the right of the minimum point the dark space was absent, while for points to the left of the minimum the dark space was always present. It was found that the effect of using as the + carbon a Carré carbon, in which the core had been bored out, was to obtain a curve closely resembling that obtained when both carbons were solid. On filling this hollow carbon with plaster of Paris or kaolin the resistance of the arc became positive. The above experiments were made with the + carbon uppermost. Other experiments made with the arc inverted showed that with solid carbons the resistance was not appreciably altered by inverting the arc. With cored carbons, however, the resistance as well as the physical character of the arc was altered, for on inversion the dark space disappeared and the resistance considerably diminished. If, however, the conditions under which the arc was

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burning were such that the dark space was absent, then inverting the arc did not alter the resistance. Attempts were made to measure the "true resistance" of a direct-current hissing arc, but it was found that even with the alternator at rest there was a large deflection of the electrometer, showing that the current through a hissing arc was oscillatory. In order to elucidate the marked difference between their results for cored carbons and those deduced from Mrs. Ayrton's curves, the authors made a series of measurements at low frequencies. They found that there is a critical frequency above which the resistance has a positive value which is independent of the frequency, and below which it has a negative value, this critical frequency being between 75 and 0. In order to investigate the sign of the resistance at low frequencies, the vibrations of the needles of the ammeter and voltmeter were made use of. By an arrangement of mirrors the needles and scales of both instruments could be observed simultaneously. In this way it could be seen whether the two needles were at any instant vibrating in the same or in opposite directions. If the needles vibrate in the same phase—*i.e.*, if an increase of P.D is accompanied by an increase of current—then the "resistance" must be positive, while if they are vibrating out of phase—*i.e.*, if an increase of P.D. is accompanied by a decrease in current—then the "resistance" is negative. An attempt to run the arc off a continuous current dynamo failed, since even with the alternator at rest the electrometer showed a large deflection, evidently due to the oscillation of the current owing to the commutator of the dynamo having a finite number of segments.

Prof. A. Gray doubted whether it was right to give the name "true resistance" of the arc to the slope of the curve connecting the potential difference (V) and the current (A). The author's method of deducing $d\,V/d\,A$ was only true if the curve was a straight line.

Mrs. Ayrton said that with reference to the question of the existence of a back E.M.F. the evidence tended to show that it did not exist. By using an exploring carbon no constant back E.M.F. could be found.

Prof. Ayrton said that, considering the arc as consisting of a back E.M.F. and a resistance, it was necessary to separate these two. Simply obtaining one value of the P.D. and the current was of no assistance in solving the question, but a series of values had to be taken. By taking the change in P.D and current sufficiently small, the curve over the range considered was practically straight. It was curious to note that as long as observers obtained a positive value for the resistance of the arc no fault was found with the method, but that now a negative value was found the accuracy of this method was questioned. If a back E.M.F. did really exist, then it followed that the arc must have a negative resistance. Mr. Frith had shown why some people had got positive and some negative values for the resistance of the arc, and also that with an alternating current it was possible to get either one or the other.

Mr. T. Carter asked if the fact that the arc had a negative resistance did not imply a back E.M.F. in order that the arc might be stable? If so, was a negative resistance such an absurdity?

Mr. Campbell said he was very pleased to see that the authors had applied a method which he (Mr. Campbell) had suggested for measuring pulsating currents. If a pulsating current such as could be obtained by means of a make and break was passed through a thermopile you would get a back E.M.F., while if an alternating current were employed you would not.

Mr. Frith, in his reply, said that he had defined the "true resistance" as $d\,V/d\,A$. Mrs. Ayrton had shown that an arc would not run unless a certain resistance was placed in series with it, and this resistance must be numerically equal to the negative resistance of the arc itself.

Prof. Ayrton said Mr. Frith's remarks as to the cause of the want of stability of an arc without outside resistance were most suggestive.

The **Chairman** (Captain Abney) said he did not like the expression P.D. He suggested the employment of photography to facilitate the accurate registration of the instrument readings.

The further discussion on the paper was adjourned.

LEGAL INTELLIGENCE.

COLLISION WITH A MANX TRAMCAR.

In the Common Law Division of the Manx High Court at Douglas, on Saturday, before Deemster Drinkwater, the hearing of the action of Wm. Henry Lawson *v.* the Isle of Man Tramways and Electric Power Company, Limited, was continued and concluded before a special jury. Mr Kneen was for the plaintiff, and Mr. Ring and Mr. Brown were for the company. The plaintiff claimed damages in respect of injuries to his horse, carriage, and person from a collision with a tramcar, alleging that such injuries were caused by the negligence of the company's servants. The company denied negligence, and pleaded contributory negligence.

A visitor named **Spencer**, from Stockport, having given evidence absolving the company from negligence,

Mr. Ring contended that the injury to Lawson was suffered by his own reckless driving, and the negligence was solely with himself and not the company.

Mr. Kneen addressed the jury for plaintiff, and the judge reviewed the evidence, summing up strongly in favour of the plaintiff.

The jury found a verdict for the plaintiff for £30, being £25 for damage to horse and carriage, and £5 personal injuries.

COMPANIES' MEETINGS AND REPORTS.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Wednesday at Winchester House, E.C., Mr. C. W. Earle presiding.

The **Chairman**, in moving a resolution for the adoption of the report and the payment of dividends, remarked with satisfaction on the turn which had been taken in the long-continued decrease in their traffic receipts, there having been an improvement of £1,083 as compared with the receipts for the December half of 1894. It was true that that amount had almost been wiped away by the loss of the French subsidy for Guadeloupe, but this they had foreseen, and was a loss which they had no means of escaping from. Their traffic receipts, in view of the fact that they had about 5,000 miles of cable and that they served 16 colonies, were almost ridiculous, the gross amount being about £2,500 a fortnight. The expenditure was kept down to the lowest possible sum consistent with an effective service. They had put into the system less cable by 30 knots than they did in the corresponding period of the previous year, and this had caused a considerable diminution in the expenses under this heading—£2,831, compared with £5,876. They brought home the "Grappler" to take out a new supply of cable for stock. If they had not done this, they would have had to charter a vessel out, and therefore they had charged this cable with a fair amount of the cost of the two voyages of their vessel. This had saved them about £2,000, but for which they would not have been able to pay the dividend now proposed of 6d. a share on the ordinary shares. Since the close of the half-year the St. Vincent subsidy had been reduced from £600 to £400 owing to the financial condition of the colony. Probably most of those present had seen Mr. Chamberlain's answer in the House of Commons when he was asked about laying a cable between Bermuda and Jamaica. They had been in correspondence with the Colonial Office on this matter, and at the proper time, if anything were settled, they would place it before the shareholders and ask their opinion upon any terms which might be proposed to them. The question of that cable was a very old one. In 1882, when it was advocated, and very strong pressure was then put on the then Government to lay it, Mr. Fawcett, who was then Postmaster-General, expressed the belief that there would be just cause for complaint against her Majesty's Government if it were to subsidise a rival company. Influenced by those words, their Company went on its course, and continued the duplication of its system, which had given permanent security in communicating to the West Indies. It would, therefore, be very unjust to employ the taxpayers' money to run a competitive line to this Company's in view of the statement made by Mr. Fawcett which he had quoted.

The resolution was seconded by **Mr. W. Andrews**, and carried unanimously.

READING ELECTRIC SUPPLY COMPANY, LIMITED.

The second annual general meeting of this Company was held last week, Mr. Henry Collins (chairman) presiding.

The directors' report and accounts for the year ending December 31 showed for the year an income of £1,453. 10s. 7d. and a balance of £22 13s. 4d. This they considered very satisfactory, seeing that the new central station had been only in use for the last two months of the year, and with an increased demand for current they anticipated a corresponding increase of revenue. Since the new station had been opened the number of consumers had increased rapidly. Thus on December 31, 1894, there were 38 consumers and 2,150 lamps wired; on December 31, 1895, 83 consumers and 4,300 lamps; on April 17 last, 106 consumers and 6,094 lamps; at present, 115 consumers and 6,647 lamps. Owing to this increase, it had been found possible to reduce the price of current from 8d. per unit, with discount, to a net 6d. per unit. For motive power, cooking, heating, etc., the directors had decided to supply current at the reduced rate of 3d. per unit, and they anticipated that as soon as it was generally known that current was available for the purposes named a considerable accession of business would result.

The report was adopted, and Messrs. H. Collins and J. C. Fidler, the two retiring directors, were re-elected, and Mr. Geo. May, of The Warren, Caversham, was further elected a member of the Board.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Hamburg.—The Finanz Deputation want tenders for a crane for the electricity works by 26th inst.

The Hague.—The Dutch Colonial Office wants tenders by 27th inst. for the supply of galvanised iron wire for the telegraphic service.

Breslau.—Tenders are wanted by May 27 by the Breslau Stadtbau-Deputation for lightning conductors for a school building.

Mako (Hungary).—The municipal authorities of Makö in Hungary are desirous of receiving proposals for the electric lighting of the town.

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Prague (Austria).—Tenders are wanted by June 1 for an electric lighting central station for the city of Prague. Application should be made to the Stadtrath, Prague.

London, S.E.—Tenders are required for complete installation of electric lighting. For particulars apply by letter to Mr. H. Freeman, 44, Knatchbull-road, Camberwell, S.E.

Penaranda de Bracamonte.—Tenders for electric lighting of the town for a period of 15 years may be sent to the authorities at the Casa Consistoria, Peneranda de Bracamonte, Spain, by May 28.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years Tenders should be sent in by August 31.

Santiago de Chile.—The Telegraphic Department of the Chilian Government will receive tenders up to June 6 for the supply of 5,000 glass jars for Leclanché cells and about 3½ tons of sal-ammoniac (pure).

Coblentz.—Tenders are wanted by 30th inst. for the annual supply of 10,000 to 13,000 wooden telegraph poles for four years. Particulars from the offices of the Konigl. Ober-Postdirection, Coblentz, for 30pfg. (3d.).

Lisbon.—The Royal Portuguese Railway Company will receive tenders up to June 3 for the supply of small telegraphic stores. Application to the Chief Engineer, Stores Department, Santa Apolonia Station, Lisbon, and particulars also obtainable at 28, Rue de Châteaudun, Paris.

Paris.—Tenders will be received by the Prefect of the Seine at the Paris Tribunal de Commerce on May 23 for the installation and working for 10 years of the electric light at the Hospice de Brévannes. The estimate is about £5,533, and the maximum annual payment 27,600f. (about £1,080).

Oldham.—The Electric Lighting Committee invite tenders for supplying them with a jet condensing plant capable of condensing 25,000lb. of steam per hour. Copy of specification may be obtained on application to Mr. Arthur Andrew, Gas and Water Offices, Oldham. Tenders to be sent in by 26th inst.

Gisburn.—Tenders are invited for the various works required in erection of new buildings for electric lighting plant and homestead purposes at The Woodlands, near Gisburn, for Chas. J. Massey, Esq., J P. Quantities may be obtained on application to Mr. Charles Parsons, architect, 9 Grimshaw-street, Burnley.

Spandau.—Tenders are wanted at the Royal Small Arms Factory for 900 incandescent electric lamps by July 17 and for 27,300 sets of arc-lamp carbons by June 12. Particulars are obtainable for 75pfg. (9d.) from Die Königl. Direktion der Gewehrfabrik (Geschäftszimmer No. 21), Spandau.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality. Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Burton-upon-Trent.—The Council require tenders for the supply of 25,000 tons, or a portion thereof, of best screened gas coal. Forms of tenders and conditions of supply may be obtained upon application to Mr. F. L Ramsden, manager and engineer Gas and Electric Light Works, Wetmore-road, Burton-upon-Trent; and sealed tenders, endorsed "Coal," are to be delivered to the manager at or before 10 a.m. on 27th inst.

Dresden.—The Telegraph Department of the Saxon State Railways want tenders by June 10 for about 50 tons of galvanised iron wire (4 millimetres) and 10 tons of smaller sizes; also 3,700 glass jars (various) for battery cells, and 10,000 porcelain insulators large size and 2,000 of smaller sizes as well as 7.500 zincs for Meidinger and 1,000 for Leclanché cells. Particulars from Die Königl. Magazin-Verwaltung, Dresden-Friedrichstadt.

Aberdeen.—Tenders are required by the Corporation for supplying and erecting boilers, feed-water heater pumps, and piping, for the electricity works extension. Copy of specification, conditions of contract, and form of tender may be obtained and drawings seen at the Electrical Engineer's Office, Cotton-street, on payment of £1. 1s. Sealed tenders, endorsed "Tender for Boilers," and addressed to the Town Council of Aberdeen, to be lodged at the Gas and Electricity Office, Town House, Aberdeen, by 10 a.m. on 27th inst.

Bucharest.—Tenders are wanted by the Municipal Administration of Bucharest by June 24 for a concession for lighting the city for a period of five years. A security of 15,000 lei (about £600) will be required. The Municipal Authorities of Bucharest ask for further tenders up to June 24 for lighting the suburbs and environs "on a system without (underground) pipes more suitable than those that have been already offered." It is desired to replace 3 265 petroleum lamps, and the contract will be for five years. Communications should be sent to the Mairie at Bucharest. Tenders are wanted by the Roumanian Postal and Telegraph Department at Bucharest for the supply of about three tons of sulphate of copper and two tons of sal-ammoniac. Tenders must be in by June 1.

Hammersmith (London).—The Vestry want tenders for the following: (*a*) the supplying and laying of high-pressure and low-pressure cables and pipes; (*b*) the supply and erection of arc lamps and lamp-posts; (*c*) the supply and erection of transformers and sub-station equipment; (*d*) the supply and erection of a five-ton overhead travelling crane. Specifications, general condition, and form of tender can be obtained at the office of Mr. A. H. Preece, 39, Victoria-street, Westminster. Applications for any one or all of the above sections must be accompanied by a cheque for £2. 2s. which will be refunded on receipt of a bona fide tender. Sealed tenders, endorsed "Cables," "Arc Lamps," "Transformers," or "Crane," must be delivered at the offices of the Vestry. 57, Fulham Palace-road, Hammersmith, by noon on 27th inst. Mr. W. P. Cockburn, vestry clerk.

RESULTS OF TENDERS.

Haslingden.—The contract for the installation of the electric light in a portion of the premises of the Industrial Co-operative Society has been let to Messrs. Simpson Bros, of Hapton.

Tunbridge Wells.—For the supply of two large boilers, one small one, and a feed-water heater, for the Lighting Committee, the tender of Messrs. Babcock and Wilcox at £1,497 was accepted.

Hampstead.—Wright's Patent Heater Condenser Company, 16, Great George-street, Westminster, have received the order for the steam and exhaust pipes and feed-water heater for the electric lighting station. Their price was £967, including Berryman heaters with special gear for lifting the casing for cleaning purposes.

Brussels.—The lowest tender on May 13 for alterations in the water supply and electric lighting at the Marbehan Station was that of Messrs. F. Parisse-Gerard, of Thibessart, at 33,777fr.; and for reconstruction work at the electric lighting station and machine shops at Arlon Station the lowest tender was that of Messrs. Bounameaux, of Jemelle, at 79,820fr. The estimate for this was 69,026fr.

Frankfurt a.-Main.—The lowest tenders on May 9 for the supply of telegraph poles 7 metres, 8½ metres, and 10 metres long, were those of J. Himmelsbach, Friesenheim, Baden, at 5·73 marks, 7·30 marks, and 9·30 marks respectively, delivered at Frankfurt-a.-M., and treated with corrosive sublimate, and of the same named firm at Freeburg, Baden, at 4·76 marks, 6·16 marks, and 7 97 marks treated with chloride of zinc and delivered at Gelnhausen.

Portsmouth.—The following tenders were received by the Guardians of the Portsea Island Union for wiring part of the main building of the workhouse for lighting by electricity:

J. R. Penning (accepted)	£52	10	0
Sussex Electrical Company	44	15	0
W. H. Sabine	55	0	0
C. Forbes and Co.	70	12	4
Sotheby and Co.	81	15	0
Sharp and Kent	97	0	0
A. E. Squire	107	15	0
Brown and May	113	0	0

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,375.

Wrexham.—The Board of Trade have revoked the Wrexham Electric Light and Power Order, 1890.

New Address.—The Midland Electric Company have removed to larger premises at 270, Broad-street, Birmingham.

Bangor.—It is reported that a company is about to apply to Parliament for a provisional order to supply the town with electricity.

New Company.—The Blackheath and Greenwich District Electric Light Company, Limited, has just been registered with a capital of £5,000.

Hartlepool.—Major Cardew and Colonel Yorke have visited the neighbourhood and inspected the new electric trams on behalf of the Board of Trade.

Hampton.—At the District Council meeting a draft agreement relating to an electric bell circuit and Mr. Graham's house and the police station was received from the Postmaster-General and approved.

Lead Oxide Company, Limited.—This Company has been registered, with a capital of £20,000 in £1 shares, to carry on business as smelters, manufacturers of and dealers in lead, lead oxides, etc.

Darwen.—At a meeting of a sub-committee of the Town Council the question of the Corporation supplying electric light was considered, and it was decided to engage an expert to go fully into the matter and report.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending May 17 amounted to £1,125, as compared with £1,141 in the corresponding week of the previous year, being a decrease of £16.

Hammersmith.—The Electric Lighting Committee of the Vestry have appointed James George Egan as clerk of works, at 3½ guineas per week, his duties being to superintend the erection of the building in connection with the electric lighting.

Cardiff.—The Electric Lighting Committee of the County Council have resolved to recommend the extension of the mains from the infirmary to Clifton street, and from Canton Bridge along Cathedral-road as far as the corner of Plasturton-place.

Ayr.—The Town Council have been authorised to borrow a further sum of £5,000 for the purpose of capital expenditure under the burgh electric lighting order of 1890. Sir W. Arrol has requested that his mansion may be supplied with the light.

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Folkestone.—We understand an offer has been made by Mr. William Slingo, representing a London firm of electricians, to take over the provisional order about to be granted to the Council.

Liverpool.—At the Liverpool Finance Committee's last meeting plans were submitted from the Liverpool Electric Light Company for the erection of a chimney 145ft. high in connection with a generating station in Paradise-street. The committee approved of the plans.

Wiring.—Under the auspices of the Electrical Trades Union, Mr. F. Bathurst, of the Interior Conduit Company, is to address the London wiremen on the subject of the "Wiring Question," at the Club Union Buildings, Clerkenwell-road on Wednesday evening next.

Germany —It may be noted that the Allgemeine Elektricitäts Gesellschaft and the Elektron Companies propose to make a considerable increase in their capital accounts. The latter company has interests in common with the Griesheim Electro-Chemical Works.

Mitchelstown.—At a meeting of the Guardians, Mr. Patrick Fitzgerald gave notice that he would on that day month move that powers to light the town by electricity under the Electric Lighting Act of 1881 be vested in the Guardians as the local executive authority.

Aberdeen.—At the meeting of the District Committee, an application by the Northern Electrical Lighting Company, asking permission to lay mains under the Deeside-road from Middleton to Bieldside, was submitted and remitted to the Road Sub-Committee with powers.

Banbury.—A meeting of persons interested in the development of telephonic communication has been held under the auspices of the National Telephone Company, Limited, when Mr. F. W. Taylor, of Reading, district manager to the company, gave an explanation of the scheme.

County of London and Brush Electric Lighting Company.—A second issue of 10,000 preference shares was made last week, and we are informed that applications to over four times the amount offered were received from the public. This fact speaks volumes for the stability of the Company.

Middlesbrough.—At the meeting of the Town Council Alderman Jones moved in favour of the introduction of the electric light, and the immediate laying down of plant at a cost not exceeding £10,000. Mr. Forbes seconded, and the debate, after being carried on for some time, was adjourned.

Fleetwood —Councillor Shuttleworth had been added to the Electric Lighting Committee. The Corporation propose to dispose of their electric lighting order, and, it is said, to Messrs. Bennett and Druce of Preston, who will amply recoup the Corporation for all the expenditure they have incurred in the matter.

New Cable-Laying Steamer.—Messrs. David J. Dunlop and Co., Port Glasgow have launched a twin screw steamer of 750 tons register to the order of the New Zealand Government for cable-laying purposes. The steamer is named "Putanekai," and will be supplied with two sets of triple-expansion engines by the builders.

Arran.—The telephone between Brodick on the east side and Dugary on the west side of the island, which was erected in 1891, has now been thoroughly renewed. New instruments with patent batteries have been fitted up, the whole work having been executed by Mr. Letton, one of Cox, Walker, and Co.'s men from Edinburgh.

Limerick.—Prof. Kennedy, with Mr. William E. Corbett and Mr. Baker, have visited Killaloe with the object of reporting on a site for supplying the city with electric lighting They also visited Doonas and the Clareville Waterworks, where they were met by the Mayor (Mr. Wm. N. Nolan), the high sheriff (Mr. Joseph Gaffney), etc.

City and South London Railway.—The returns for the week ended May 17 were £864, compared with £905 for the corresponding period of last year, being a decrease of £41. The total receipts for the half-year terminating as above were £18 800, compared with £18,720 in the same period of the preceding year, being an increase of £80.

Swansea.—The negotiations between the town clerk and the tramways company in reference to the triple scheme are proceeding satisfactorily. We understand that the engineer to the company, Mr. Kincaid, is instructed to visit Swansea, when a conference will be arranged with him and the Electric Lighting and Tramways Committee.

Appointment Vacant.—The Lincoln Town Council propose to appoint an electrical engineer at a salary of £300 a year, whose duty it will be to design and superintend the carrying out of a continuous-current electric lighting system for the city. Particulars can be obtained on application to Mr. H. R. Hebb, St. Peter's-churchyard, Silver-street, Lincoln.

Hackney.—The Guardians have accepted the recommendation of the Building Committee, who, after consulting with Mr. W. A. Finch, their architect, advised that no further action be taken with regard to the provision of an electric light installation at the new infirmary pavilion. Mr. Beurle fought strongly for the adoption of the electric system, but without avail.

Coatbridge.—A discussion took place at the Council meeting on a recommendation of the committee on acquiring the gas and electric lighting works that an offer of £75,000 be made for the gas company's works, being in their opinion £4,900 in excess of the present value of the shares It was decided, however, by six votes to four, to make no further negotiations in the matter.

Blackpool —Electricity will be largely employed in producing some novel effects in the series of spectacular ballets at the Winter Gardens this season. Mr. Quinn, of Brighton, has been appointed borough electrical engineer at a salary of £300. He was second in command at Brighton Corporation Electricity Works. Mr. Cooper has been appointed assistant to Mr. Quinn at a salary of £130.

Portsmouth.—The consent of the Town Council has been given to the carrying of electric light mains through St. Ronan's-road, at an estimated cost of £200, and it was decided to apply to the Local Government Board for power to borrow £6,000 for various works connected with the extension of the system. This formed part of the general application made some time ago for £20,000.

Telegraphic Communication with Lighthouses.—The Plymouth Chamber of Commerce, in replying to a statement made by the secretary of Lloyd's, insists on the paramount necessity that lighthouses, when built, should be utilised to the fullest extent possible for the saving of life and property by putting them into telegraphic communication with the general telegraphic system of the country.

Yarmouth.—At the meeting of the Town Council the Electric Lighting Committee reported that in April eight additional customers had applied for 388 lamps, raising the number of customers to 168, and of lamps to 7,991. The income for the month was £145. 16s. 8d., and expenditure £129. 11s. 2d. The repayment of capital, interest, etc., now amounts to about £1,000 a month.

International Exhibition.—A Central American international exhibition is to be held in the capital of Guatemala from March 15 to July 15, 1897. Exhibits from any country will be admissible so far as they fall under the heading of science, mechanics, construction, etc. Information may be obtained at the London Chamber of Commerce, Eastcheap, E C., between the hours of 10 a.m. and 5 p.m.

Edinburgh.—Arrangements have been made with the Post Office authorities by which the subscribers to the National Telephone Company's local exchange system may telephone their telegrams direct to the Post Office by means of the exchange instruments fixed upon their premises. Telegrams may also, where the Post Office regulations permit, be transmitted from the post office to subscribers in a similar manner.

Carlisle.—At the meeting of the Town Council Mr. Buck asked what position the Gas Committee were in with regard to the electric light Mr. Corbett said the provisional order had been obtained, and at an early date the committee would be in a position to report upon the question They had no intention of letting the matter sleep. Barring the new supply of water, it was the most important matter the committee had under consideration.

Cardiff.—At a meeting of the Tramways Committee Councillor Robinson urged the committee not to make any agreement which did not allow of the use of electricity, and quoted figures to show that in America electricity was fast displacing horse-power as a motive power for tramcars. The Chairman explained that the tramway directors had expressed their willingness, if it seemed advisable, to take the electric power from the Corporation.

Luton.—The Electric Lighting Committee reported at the Town Council meeting that they had elected Councillor Green as chairman. They had also resolved that the Town Council should become a member of the Municipal Electrical Association for one year, and the town clerk is to remit the fee of £1. 1s. Councillor Wilkinson was appointed to attend as a delegate at the annual convention of the association on June 10, 11, and 12. The report was adopted.

New Electric 'Bus Company.—The London Electric Omnibus Company, Limited (Ward's system), has been formed with a capital of £250,000 in £1 shares, of which 170,000 are now issued, to take over from a syndicate the patents relating to Mr. Radcliffe Ward's system of electric street traction. The price under which the Company acquires the exclusive license for England for the patents is £100,000, of which £20,000 will be paid in cash, and the balance in fully-paid shares.

Morecambe.—Mr. Bellamy moved at the meeting of the District Council that a committee should be appointed to look out for a site for electrical works for supplying electric light, to suggest a scheme for supplying the light, and prepare for application to the Board of Trade and the Local Government Board, with power for the committee to visit electrical works. He practically moved the reappointment of the old committee, but it was eventually decided that the committee should comprise the whole Council.

Skye.—The telegraph is about to be extended to Staffin. Mr. Baillie has received the following letter from the Scottish Office: "With reference to previous correspondence respecting the extension of the telegraphic system to Staffin, I am directed by the Secretary for Scotland to state for your information that provision has been made out of the vote for the year 1896-97 for public works and communications in the highlands and islands of Scotland for the purpose of carrying out this extension."

Brown, Boveri, and Co.—We have received from Messrs. Brown, Boveri, and Co, of Baden, Switzerland, and Frankfurt-on-the-Main, an illustrated description (in German) of their alternate-current (single-phase) motors, with particulars and testimonials relating to the installations made by them or in which their machines have been used. The book is in the usual square catalogue form, but it would be hardly right not to mention the tasteful way in which the colour-printing is done, or the excellence of the process-prints of the machines.

Helmington Row.—The question of lighting was brought up at the Parish Council meeting. The Chairman said it was hopeless to expect that they could get gas, as the Crook Company had

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absolutely refused them it. Mr. Gaines thought they had better go in for the electric light. Messrs. Straker and Love had ample plant at Sunnybrow to supply the whole district. Mr. Steele said there was ample power; all that was necessary was the cable putting in. Ultimately the question was referred back to the committee to make further enquiries.

Wakefield.—At a joint meeting of the Sanitary, Sewerage, and Electric Lighting Committees of the Corporation for the purpose of opening the tenders sent in for the new electrical works in Calder Vale, the tender of Messrs. Holme and King, of Liverpool, at just over £8,000, was accepted for the bulk of the buildings. Several from local tradesmen were accepted for minor portions of the work. The contract for a chimney shaft 180ft. high has been let to Mr. William Thickett, of Horbury, for £2,532. 7s. 9d The loan borrowed for the works amounts to £25,000.

Oldham.—At the meeting of the Corporation Alderman Goodwin proposed that the standing orders be suspended in order that the minutes of a meeting of the Technical Education Committee containing a resolution that the contract for wiring for the electrical installation be let to the firm of W. A Shaw and Co., of Stockport, might be considered. He added that the firm had done good work in the town, and for the Corporation, in the past, and their tender had been considered the best out of about 30. The orders were suspended, and the minutes were unanimously approved.

Birmingham. — Mr. William Mackenzie, president of the Toronto Railway, and Mr. James Ross, managing director of the Montreal Street Railways, have made an offer to purchase the business of the Central Tramways on the basis of par value for debentures and preference shares, and a bonus of £1 on the ordinary shares, which were originally £10, but two years ago were written down to £5. The total amount would be about half a million. In a circular which the directors have issued they warmly commend to the shareholders acceptance of the proposal.

Burton.—At a meeting of the Town Council two letters were read from Mr. Aston Webb, the architect for the rebuilding of the infirmary, asking if the infirmary could be supplied with electric current in a year's time, if the main could be brought to the building. and what the cost of the current would be. The Council replied that the supply would be afforded at the usual price, and for the cost of any extension of service lines upon private property. The manager has been instructed to obtain and fix two additional transformers on the High and Station streets electric light mains, at a cost of about £100.

Watford.—In accordance with notice, Councillor G. P. Neele moved, at the Urban District Council meeting, "that steps be at once taken by the Council to obtain the needful legal authority for the introduction, under their control, of the system of public electric lighting into Watford, it being then left for subsequent discussion whether the Council will retain the working in their hands or transfer (under the provision of the Electric Lighting Act) the liability to a local company or syndicate." In doing so he spoke of several places where it had been successfully taken up Councillor Pridmore seconded, and the resolution was carried.

Southend.—The Highways and Works Committee recommended at the Town Council meeting, the lighting of the whole town with incandescent gas lamps for a period of three years at an increased annual cost of £272. 15s. 10d. Councillor Bowmaker (chairman of the Electric Lighting Committee) strongly opposed the recommendation. The report from Prof. Robinson, he said, had just arrived, and he asked for time for its consideration. This haste was unseemly; it was grossly unfair to the Electric Lighting Committee. He moved that the question be adjourned for six months. In the end the report of the committee was adopted.

Gulcher Electric Light Company.—Mr. C. Fitch Kemp, the liquidator of the Gülcher (New) Electric Light and Power Company, has issued a final report, from which it appears that there is no reasonable prospect of paying the second debentures in full unless a claim on the New Zealand Electrical Syndicate can be realised, as to which he is not hopeful. He recommends that an offer of Lloyd's Bank to take over the liabilities and assets of the Company should be accepted, but desires to take the sanction of the creditors and contributories before accepting it. A meeting for that purpose has accordingly been called at 73, Lombard-street, at 12 o'clock on May 26.

Dewsbury.—A deputation from the governors of the Dewsbury and District Technical School, consisting of M ssrs. S J. Chadwick, C. B. Crawshaw, and F. W. Reuss, has waited on a committee meeting of the Town Council, and asked that the committee would lay down the necessary mains for supplying the technical school with the electric light. Consideration of the subject was deferred to a special meeting. The Council have decided that the fittings for the electric light for the new baths and library should be made for a voltage of 220, instead of 110, at an extra cost of £11. The deficiency on the electric lighting account for the year ended March 31, 1896, is £385. 7s 3d.

Sunderland.—At a meeting of the Town Council Alderman Bruce proposed the adoption of the Electric Lighting Committee's report, which was to the effect that on and after October 1 next the terms for the supply of electrical energy for lighting purposes be reduced by 1d. per Board of Trade unit – viz., from 6d. to 5d.— with the same discounts as heretofore During the past year 95,446 units of electrical energy had been produced at the Corporation station, for the support of which £701 had been taken from the rates. This sum, however, could not be reckoned as a loss, for the buildings were not yet paid for. It was intended to largely increase the service during the ensuing few months. The report was adopted.

Kingswood.—At a meeting of the District Council a communication was read from Messrs. Parfitt, electric light contractors to the Council, offering for sale the whole of the present installation in the Kingswood district. The letter further suggested that now was a good time for extending the light, if the Council was so disposed. Mr. Peacock said he quite agreed with Messrs. Parfitt that if they intended to have an extension of the light, it should be commenced at once, before the winter came on. The Chairman asked whether the Council would not do better by waiting a little longer. After further discussion, the matter was referred to the Lighting Committee.

Municipal Electric Association.—The first meeting will be held on Wednesday, June 10, in London. On that day Mr. Arthur Wright will deliver his presidential address, and papers will be read by Mr. A. S. Barnard (Hull), Mr. H. W. Couzens (Taunton), Mr. C. H. Wordingham (Manchester), and Mr. A. B. Mountain (Huddersfield). On the following day papers will be read by Mr. Arthur Wright (Brighton), Mr. J. A. Jeckell (South Shields), Mr. E T. Ruthven Murray (Worcester), and Mr. J. Hesketh. Friday morning will be devoted to a business meeting, after which, a visit will be made to Brighton, when a paper will be read by Mr. A. H. Gibbings (Bradford), and the Corporation electricity works will be inspected.

Brighton.—The Lighting Committee recommend the acceptance of the tender of Messrs. Skeats and Co, Queen's-road, to put up 450 street gas-lanterns for incandescent electric lamps for £180 and 8s. for each additional lamp. It is recommended that the electricity main be taken up Islingword-road as far as No 126, and that the street lamps in that road to that point be fitted with incandescent electric lights. Portions of Eaton-place and Carlton-hill are to be similarly lighted. The Bill which extends the time for the completion of the Brighton and Rottingdean Seashore Electric tramroad has been referred to the Unopposed Bill Committee of the House of Lords. This Bill has already been sanctioned by the House of Commons.

Dublin.—The tramways were opened for traffic last Saturday, and met with extraordinary success. Large crowds availed themselves of the new means of transit, and although there were 28 cars in the service this number was not at all equal to the traffic, and people had to wait in some instances nearly an hour before they could get seats. The cars ran smoothly and without the slightest hitch, and everything in connection with the traffic promises well. There was no formal opening ceremony. except that the Lord Mayor drove the first motorcar from Dalkley to Dublin. We regret that, owing to its late arrival, we were unable to reproduce the photograph of Mr. H F. Parshall, the consulting engineer, in our description of the tramways last week.

Sussmann Electric Miners' Lamp Company, Limited.—This Company has been formed with a share capital of £80,000 in 39,250 7 per cent. cumulative preference shares of £1 each, 39,250 ordinary shares of £1 each, and 1,500 deferred £1 shares, to acquire the various British, foreign, and Colonial patent rights for the Süssmann lamp, which is a portable electric lamp for coal and gold mines, and to supply it to large users. Subscriptions were invited for an issue of 31,750 preference and 31,750 ordinary shares. The purchase price has been fixed at £45,000. payable as to £10,000 in cash, out of which the expenses of this issue will be defrayed, £1,500 in deferred shares, and the balance either in cash or shares, or part of each at the option of the directors.

Bury St. Edmunds. — The Electric Lighting Committee appointed last October have completed their report. This has been printed, but will not be published until it goes before the Council in the middle of next month It may be said, however, that the final decision of the committee is to recommend that mains for private supply should be laid over an area comprising the centre of the town, and that a three-wire continuous-current system at the higher voltage (200 volts) should be adopted. It is further recommended that the public lighting should be undertaken throughout the whole of the borough, for which about 450 16 c.p. incandescent lamps and four arc lamps will be required. The total estimate is £21,400. Mr. F. H. Medhurst is the consulting engineer.

Ashton.—The electric tramways company appear to be inclined to co-operate in a very friendly way with the Corporation. The company suggest that they and the Corporation might work into each other's hands to the mutual advantage of both. Both the Corporation and the company have been contemplating the erection of generating stations, and the company suggest that the whole thing might be arranged under one roof. They suggest that the company should be supplied with power by the Corporation, and of course this would add considerably to the capital outlay of the Corporation in connection with their installation, but the company may not be able to wait for the slow operations of the Corporation in this matter. The suggestion may accelerate their rate of progress.

Guildford.—At the meeting of the Town Council a letter was received from the Board of Trade enclosing a letter which the Board had received from Mr. Folkard, secretary to the Guildford Electric Light Company. The letter stated that the details of the method in which the main cables were to be laid having been now settled, the company had given notice to the authorities and were now prepared to take up the streets with a view of laying down the mains, and also to deposit the stipulated £500. They therefore asked the Board to allow the company to make an immediate start on the mains. The number of shares actually allotted was 979, with a promise of another 100, which more than covered the first contract for the work, which covered all the mains in the scheduled streets.

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Calcutta.—The *Indian and Eastern Engineer* says there is very little foundation for the statement that the Calcutta Tramways Company have arranged to work their cars by electric power. It seems that negotiations with an English firm have been carried on with this object in view, but the existing track is in such a condition that it would have to be entirely relaid with modern rails before electric traction could be applied with any chance of success. An offer, we are told, has been made to the company to take over their property, but how far this is the case we are unable rightly to ascertain. This much we can affirm, that Calcutta is, in respect of her tramway system, as much behind the age as in every other matter which pertains to the good of the city and the convenience of its population.

Whitehaven.—At the Town Council meeting it was reported that at a meeting of the Water and Lighting Committee on April 14, a letter having been read from the Harbour Commissioners stating that they had resolved to rest on the existing agreement for the lighting of the harbour by electricity, also read the resolutions of the trustees of the town and harbour, dated July 25, 1893, it was resolved that the Council carry out the terms of the existing agreement, and the surveyor was instructed to do what was necessary for that purpose. The engineer read correspondence which had passed between himself and Messrs Siemens Bros. as to the cost of opening and closing the trenches in connection with the renewals of defective cables. At a subsequent meeting a letter was read from Dr. Hopkinson expressing his opinion on this subject, and the town clerk was instructed to communicate further with him and report to the committee.

Horseless Carriages.—The Great Horseless Carriage Company, Limited, with a capital of £750,000, has been formed to carry on and establish the great horseless carriage industry in this country. Extensive works, the prospectus states, with railway and canal adjoining, have been secured at Coventry. The company acquires the sole license to build horseless carriages for the Daimler Motor Company, and will work under a full license to manufacture and use the great systems now perfected, including the Pennington motor inventions Count de Dion and Mons. Bouton's improvements in steam and electricity, Garrard and Blumfield's electrical car improvements, the Universal Electric Carriage Syndicate's patents, Mons. Bollee's patented autocar, the advantages of all the Daimler motor patents, and certain inventions of Harry J. Lawson and J. J. Henry Sturney, Henry P. Holt, and others. The consideration to be paid by the company to the British Motor Syndicate, Limited, is 50,000 shares or cash in lieu thereof.

Mumbles Railway.—The directors of the Swansea and Mumbles Railway have received an exhaustive report from Mr. Morgan Williams, M.I.C.E, M.A., on a proposal to utilise electric traction instead of steam on the line The report is based on the presumption that the Corporation would supply the current necessary on an agreed price of 2d. per unit up to 600 000 units, and 1½d. up to 750,000 units; and that the Corporation lend the money for the conversion and equipment of the track, charging 3 per cent. interest on the money so employed, and a sinking fund to repay the loan within 30 years. He concluded that the price of electricity would prove dearer than steam, and the charge to bring these equal would have to be 1·29d. per unit instead of the amount proposed. Under these circumstances he does not think with the somewhat limited opportunities of obtaining detailed information that he had had, it would be advisable to undertake the conversion of the line from steam to electricity unless materially better terms were obtained from the Corporation

Exeter.—At the meeting of the City Council the Special Committee on Electric Lighting recommended that the town clerk be given counsel's assistance in drawing up the conveyance of the works to the Council, that £299. 19s. 10d. be paid to the company for extra plant, that the surveyor be requested to report to a meeting of the committee on the work necessary to be immediately undertaken in order to increase the power and efficiency of the present works, that it be recommended to the Council that it be referred to the committee to consider and report upon the arrangements which should be made for the future management and control of the undertaking, and that the secretary to the hospital be informed that from June 30 next the undertaking of the electric light company would be in the hands of the Council, and that it was the intention of the Council to run the works so as to give a supply of light throughout the whole of the 24 hours of the day, and that the Council would be prepared to make special terms with large consumers such as the Devon and Exeter Hospital. The report was adopted.

Taunton.—The Electric Lighting Committee presented the following report at the meeting of the Town Council: "Your committee report that the cables in connection with the No. 3 substation, also the arc cables, have been laid and tested by Dr. Fleming; he has also tested the transformers, and will shortly report as to the results of such tests." Alderman Potter, in proposing the adoption of the report, remarked that the committee were extremely well pleased at the expeditious and careful manner in which the work mentioned in the report had been carried out. No stones were "ruthlessly broken," but the whole thing was done in the most careful manner possible, and the thanks of the Council were due to the men for the way in which they did the work. Alderman W. H. Fowler seconded the motion, which was agreed to. The Borough Surveyor reported that the No. 3 substation for the electric light had been formed in a cellar under Mr. Councillor Sibley's shop at East Gate, the whole being made as far as possible fireproof. The entrance was made with an opening in the pavement and covered with prismatic lights in flaps, balanced so as to be easily lifted. The transformers were now in use.

Appointments Vacant.—The Corporation of Wakefield require the services of a competent person to act as clerk of works during the erection of the electricity works. Applications, in own handwriting, stating age, experience, and wages required, to be sent not later than Wednesday, May 27, 1896, to Mr. Richd Porter, city surveyor, Town Hall, Wakefield.—A practical working engineer is required for the Royal Asylum, Aberdeen. He must have a thorough knowledge of electricity, and be capable of taking full charge of steam boilers, Dowson gas plant and gas-engines, etc. Written applications only, with recent testimonials as to ability and character, to be sent to the medical superintendent by 23rd inst. Salary £2 per week outdoor.—The Improvement Committee of the Sheffield Corporation require the services of a practical engineer, with a knowledge of electrical fittings, to take charge of the boilers and the whole of the heating apparatus and electrical fittings in the town hall, and to perform such other duties as may be required. An engine-tenter or fireman will also be employed. Applications, stating age, salary required, present occupation, and previous experience, to be sent to Mr. Herbert Bramley, town clerk, Sheffield, with copies of not more than three testimonials (which will not be returned), by 23rd inst.

City and South London Railway.—The Bill promoted to extend the time for the purchase of lands for the purposes of the City and South London Railway Act, 1893, and for the completion of the underground railway and other objects came before a Select Committee of the House of Commons last week. The main question before the committee was the demolition of the church of St. Mary Woolnoth, in King William-street, near the Bank of England, for the purpose of erecting a station. Amongst other witnesses called was Mr. C. G. Mott, chairman of the company, who said the church was not wanted. There were 10 churches within a radius of 200 or 300 yards two of them being actually in the same street as St. Mary's. Besides, St. Mary's had no congregation and there were no peculiar associations connected with it. It merely resembled a room in the Mansion House. The money that would be paid for it would be sufficient to enable several other churches to be built in districts where churches were wanted and where congregations could be easily obtained. If the church were left standing the company would not have as useful a station as would otherwise be secured, and the cost of the works would be increased. The committee found the preamble of the Bill proved, subject to the insertion of a clause for the protection of St Mary Woolnoth, and declaring that it shall be referred to the arbitrator to take into consideration the additional liability which will devolve on the company in consequence of giving up their present rights.

Glasgow.—At a meeting of the committee having charge of the clocks in the city a report was submitted by Prof. Becker, who for the past six months has been experimenting at the observatory with electric clocks, with the view of an installation to give uniform time to the entire city. The committee agreed to recommend to the Corporation the removal of the installation working at the observatory to the Municipal Buildings, from which, by way of experiment, a central area with 10 wall timepieces will be worked. Should the experiment prove satisfactory, the installation will be extended throughout the entire city. A report is before the Sub Committee on Electric Lighting. According to the statement the continuous and alternating current systems are equally good for lighting the city, but for tramway motor purposes it is absolutely necessary to adopt the continuous current system owing to the Board of Trade stipulations The system recommended by the report for Glasgow, where the demand for the current will be largely concentrated within a given area, is a continuous current of 500 volts, which could be supplied direct to the street lamps and the tramways without any complications in transformers; and while the area over which 500 volts could be maintained at a constant supply from the present works is only 1½ miles, it is pointed out that three large works—two on the north side of the river and one on the south—would be sufficient to meet the requirements of the city for many years to come. The present station at Waterloo-street, it is added could be utilised until the demand on the new works enabled them to run full time.

Southampton.—It was reported at the Town Council meeting that the National Telephone Company had written to the effect that they had under consideration the question of making certain alterations to, and improvements in, their plant in Southampton, and, amongst other things, of placing the system on what was known as the twin-wire or metallic return principle, which involved the provision for each subscriber of a second or return wire. To do this effectively, and to secure the greatest efficiency of service, it was essential that the main routes of wires in the centre of the town should be placed underground, and the co operation of the Council in the matter was sought. The letter was referred to the Works Committee The Electric Lighting Committee recommended the payment to Messrs. Kincaid, Waller, and Manville of £52. 10s. for their report, etc., on the electric lighting undertaking. Mr. E. Manville had attended and conferred with the committee generally upon the electric lighting question, submitting plans of the proposed new buildings, of which the committee approved, subject to the acquirement of the extended site required. The committee having visited the works, subsequently proceeded to Portsmouth, where they were very kindly escorted over the electric light works of that borough by Alderman Ellis, the chairman of the committee, and also by the deputy-chairman. The deputation also inspected the most important thoroughfares where the electric lighting mains had been laid down. Alderman Bone thanked the Portsmouth committee for their kindness and courtesy. The report was adopted without comment, on the motion of Alderman Bone.

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Dundee.—The Institute of Engineers paid a visit of inspection to the electricity works last week. The company, which numbered about 40, was divided into two parties, and escorted over the premises by Mr W. H. Brownlee, manager, and his assistant, Mr. Tittinsor, both of whom explained the various machines and appliances used in generating and supplying the electric light. A vote of thanks, proposed by Mr. James Anderson, to the manager and his assistant for their kindness and courtesy, terminated a most enjoyable visit. Owing to the rapidly increasing number of subscribers in Dundee and district, the Telephone Company have resolved upon an important change in the numbering of the instruments At present the telephones on the Dundee centre are numbered from 1 onwards; the Broughty Ferry instruments begin at 1,200; those in Newport at 1,400; in Monifieth at 1,500; in Downfield at 1 600; and in Carnoustie at 1,700; the Dundee figures being resumed at 2,000. This system has not been found to be altogether satisfactory either to operators or subscribers. It has therefore been decided that each of the district centres already enumerated will be kept separate, the numbers in each beginning with 1, and the distinction being made by the subscriber intimating to the exchange with which of the districts he desires connection. For the sake of brevity, however, it will be sufficient to name simply the initial letter of each town. These changes will not take effect until the issue of the new directory on July 1. An exchange is in process of construction in Tayport, and will be in operation in the course of a few weeks. The new numbering will here apply equally with the other districts.

Leeds.—The Tramways Bill came before the Committee on Unopposed Bills, with Mr. J. W. Lowther in the chair, and the Standing Order of the Legislature having reference to the working of tramways by municipal corporations having been already suspended, there remained no obstacle to the passing of the Bill, which was passed with a few minor alterations which do not affect the main provisions of the measure. The effect of the Bill is to enable the Corporation to borrow £407,000 for tramway purposes, and to work the lines themselves Councillors C. H. Wilson and Clarke were present as representing the Parliamentary Committee, Councillor Hannam representing the Highways Committee, and the town clerk (Mr. J. Harrison) and the city engineer (Mr. T. Hewson). Mr. T. R. Leuty, M.P, also attended. It was reported at a meeting of the Tramways Committee that the profits derived by the Corporation out of the working of the tramways for the year ended March 25 last amounted to over £4,000. It was decided to extend the penny stage in the small cars on the Headingley route from Blackman-lane to Reservoir street; also to advertise for tenders for the erection of a power station, for bracket poles and overhead wires, engines, boilers, tramcars, and for all that will be required for the electrical tramway from Kirkstall to Roundhay. Alderman Harding has presented a scheme to the Corporate Property Committee for dealing with the open space known as City-square. He suggests that electric light should form part of the scheme of decoration, and that two bronze standard lamps should be provided at a cost of £500 and eight life-size bronze figures holding single glow lights of 500 c.p. at a cost of £1,000

Bath.—A deputation attended at the Board of Trade Office last week, consisting of the Mayor, Aldermen Jolly and Sturges, and Mr. E. W. Morris, also the clerk surveyor, and Mr. G. J. Moger, parliamentary agent for the Authority, and Mr. S. Morse, Mr, T. O Callender, Mr. E Pitman, Mr. B. Wood, and others, for the company. Sir Courtenay Boyle presided, there being also present Major Cardew and Prof. Kennedy. Sir Courtenay Boyle invited Mr. Morse to make a statement, when he urged that the Authority should take over the whole of the arc lighting plant, and pay a sum set down in the company's books for promotion money Mr. Hammond, on behalf of the Authority objected to the arc lighting plant, and to the payment of any money for preliminary expenses. Sir Courtenay Boyle stated that the Board of Trade considered the report of Prof. Kennedy to be a fair one, and that the Authority should not be asked to take over the arc plant, and asked for particulars of the preliminary expenses. He intimated that the Board would grant an order to the Authority upon its undertaking to apply for a loan to carry out the purchase at the price authorised by the Authority. The question of preliminary expenses was left to the president; Mr. Morse to furnish particulars. A special meeting of the Electric Light Committee was held subsequently to consider the report of the deputation. The matter was fully discussed, and attention was given to the new apparatus that will be required to improve the present plant at the works. A special meeting of the Urban Sanitary Authority is to be held to-day (Friday) to discuss the amount of the loan required, which will be considerably in advance of the sum at which the works may be purchased under Prof. Kennedy's valuation.

The Great Tramways Scheme.—At the meeting of the London County Council, the report of the Highways Committee was considered. This report recommended that the County of London Tramways Syndicate should be informed that the Council, having given full consideration to the proposals of the syndicate, was not prepared to enter into any arrangement with the syndicate with reference to the tramways in the county of London. The scheme of the syndicate contemplates the immediate transfer to the Council of all the tramways in the county of London, and the subsequent leasing of the whole by the Council to a company to be formed by the syndicate, the length of the lease to be 28 years from the time of purchase. The Highways Committee also reported in favour of the Council adopting an arrangement for the purchase for £540,000 of the tramways of the North Metropolitan and the London Street Tramways Companies within the county of London. Earl Russell, vice-chairman of the committee, asked that any discussion on the merits of these proposals might not be taken until the second meeting of the Council after the Whitsuntide recess. The committee were still considering the matter, and a further report would be brought up on the subject. As, however, an amendment stood on the paper to refer the syndicate's proposals to the Finance Committee, with instructions to consider and report as to their financial bearing, he would ask that that might be disposed of Mr. A. Hoare then moved, and Mr. N. Robinson seconded, the amendment referred to. The Earl of Onslow hoped that if the amendment was passed it would not be taken as a precedent. He deprecated any action on the part of the Council which would tend to lessen the weight of responsibility which fell on the members of spending committees. This amendment really meant that they were going to allow the Finance Committee to review a proposal which had been rejected by the spending committee. It was making the Finance Committee a sort of court of appeal. He should certainly vote against the amendment. Mr. B. L. Cohen, M.P., fully endorsed what the previous speaker had said. At this stage the debate was adjourned.

Chester.—The electric light buildings are now fairly started. The foundation-stone was laid on Tuesday afternoon by the mayoress (Mrs. B. C. Roberts) who was presented with a silver trowel by Mr. John Jones (deputy chairman of the Electric Lighting Committee) on behalf of Prof. Kennedy, the engineer. The stone bore the following inscription: "City of Chester, Electric Light Station. This stone was laid by the Mayoress (Mrs. Benjamin Chaffers Roberts) on the 19th day of May, 1896. Alexander B W. Kennedy, M Inst.C.E, engineer; Thomas Parker, Limited, contractor." The question of lighting the city has been before the Corporation for about five years, and among the experts who have been consulted are Dr. Hopkinson, F.R.S., Lord Kelvin, Mr. W. H. Preece, and others. Prof. Kennedy is the present consulting engineer in the matter. The tender of Messrs Thos. Parkers, Limited, Wolverhampton, which was selected out of 13, has been expanded, the consulting engineer considering that any installation for Chester should be such as to allow of the enlargement of the area of supply beyond the compulsory area first contemplated. Messrs. Parkers have agreed to run the machinery, to maintain the works, and, in fact, act as the suppliers of the electric light for a period of three years, and at a price which will be remunerative to the Corporation and within the means of the public. In the three years, any defects in the lighting or machinery will be seen, although the Corporation have the right of taking over the concern at any time on payment of a certain amount to Messrs. Parkers. The works, which are in Crane-street, will be erected in the Renaissance style, with a frontage to the street of 94ft. In front will be the offices and accumulator and meter rooms, while the engine and dynamo rooms and the boiler-house will occupy the space behind, the coal stores being in the absolute rear. The engine-room will be lined with brown glazed brick dado with white glazed brick above. At the side of the building an inclined road is to be made above the coal-stores, so that loads of coal can be tipped. The flues from the boilers pass through a Green's economiser to the chimney, which is to be 140ft. high and 7ft. in diameter inside. Altogether, the building itself will cost about £6,000, and will in all probability be finished in about five months. The architects are Messrs. J. H Davies and Son. The committee have arranged for 40 arc lamps to be erected in the main streets at once, and the lighting of the minor streets will be done more gradually.

London Extensions.—The report of the Highways Committee presented at the last meeting of the London County Council contained a statement that an intimation had been received from the Board of Trade that the application of the Vestry of Newington for a provisional order in respect of that parish would not be proceeded with. Sanction was given to the Post Office authorities to construct a 1½in. pipe connection with the troughing which carries the Post Office telegraph wires in Northumberland avenue subway opposite the Royal Colonial Institution; sanction was also given to Messrs. Ellington and Woodall, on behalf of the London Hydraulic Power Company, to lay mains in Banner-street and Leonard-street, St. Luke's, and to lay a branch from the company's main in the Queen Victoria-street subway through the bottom of the subway for the purpose of supplying hydraulic power for working the tunnelling shields used in the construction of the Waterloo and City Railway now being formed at a lower level in that street. The following notices under the Electric Lighting Acts and Orders were approved: the County of London and Brush Provincial Electric Lighting Company, to lay mains in Keswick-road, West-hill and West-hill-road; the Metropolitan Electric Supply Company, to lay mains in Upper St. Martin's-lane, Tower-street, Little Earl-street, Bloomsbury-street, and Shaftesbury-avenue; the House-to-House Electric Supply Company, to lay high and low tension mains on the south side of Redcliffe-square; the London Electric Supply Corporation, to lay trunk mains, consisting of lead-covered concentric cables drawn into cast-iron pipes, in Rotherhithe New-road and Bush-road, across St. James's-road, and in Lucey-road and Rouel-road, Bermondsey; the Westminster Electric Supply Corporation, to lay mains in Mount-street, South Audley-street, Grosvenor-square (two sides), Brook-street, Gilbert-street, Robert-street, and Davies-street; in Union-street, Hanover square, South Molton-lane, Davies-street, Berkeley-square, and Hay-hill; and in Eccleston place and street, Buckingham Palace-road, Ebury-street, Upper Grosvenor-gardens, and Grosvenor-place; and the Vestry of St. Pancras to lay mains in Albert-street. Notice had been received from the Vestry of Hampstead, given in accordance with the provisions of the Hampstead Electric Lighting Order, 1892, of intention to lay mains in and across Abbey-road. The

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Vestry is the undertaker under the order, and the Council had no power of approval or disapproval of works.

PROVISIONAL PATENTS, 1896.

MAY 11.

9950. Improvements in electrical arc lamps. William Harding Lauder, 33, Blessington-street, Dublin.

9960. Improvements in electric bell communication. Frank Helman and John Carroll, Liverpool Reform Club, Dale-street, Liverpool.

9964. Improved electric cables. George Hinde Nisbett, 15, Water-street, Liverpool.

9974. Improvements in and connected with electrical switches. Max Binswanger and Francis George Bell, 73, St. Stephen's-road, Upton Park, London

9975. Improvements in and relating to conduits for electrical conductors. Frederick Bathurst, 73 St. Stephen's-road, Upton Park, London.

9976. Improvements in hand telephones and in compound switches therefor. Max Binswanger and Francis George Bell, 73, St. Stephen's-road, Upton Park, London.

9992. Improvements relating to electric traction. Herbert James Allen, 24, Southampton buildings, Chancery-lane, London.

10015. Improvements in writing telegraphs. Richard Joseph Crowley and Alfred Blandford Hutchings, 6, Bream's-buildings, Chancery-lane, London

10017. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

MAY 12.

10047. System of and means for electrical transportation. Philip Koesuth Stern, 55, Chancery-lane, London. (Complete specification.)

10069. A new or improved method of and apparatus for electrically controlling or adjusting the position of rudders, guns, signals, and other devices. Mathias Pfatischer, Norfolk House, Norfolk-street, London

10095. Improvements in electric batteries. Paul Schmidt, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10096. Improvements in arc electric lamps. Alvie Oscar Mackin, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10106. Improvements in step-by-step printing telegraphs Walter Samuel Steljes, 24, Southampton-buildings, Chancery-lane, London.

10124. Improvements in systems of distribution of alternating electric currents. James Devonshire, 70, Chancery-lane, London. (Charles P. Steinmetz, United States.) (Complete specification.)

10127 Improvements in electric tram trolleys. Henry Harington Leigh, 22, Southampton-buildings, Chancery-lane, London. (Herbert Rudolph Keithley, United States) (Complete specification.)

10134. An improved system of and apparatus for the collection of electricity from overhead conductors and in conduits connected therewith. William John Brewer, 1, Queen Victoria-street, London (Complete specification.)

MAY 13.

10171. Improvements in thermostatic circuit closers for electric fire and heat alarms. Frederick Dresser, 20, Bixteth-street, Liverpool.

10189. Improvements in carbon brush holders for electromotors and dynamos. Frederick Henry Royce and Ernest Alexander Claremont, 53, Arcade-chambers, St Mary's-gate, Manchester. (Complete specification.)

10205. An improved tumbler or lever action switch for electric power or light. F. W. Heaton, H. Smith, and A. Lindley, Salford Switch Works, Sidney-street, Salford, Manchester.

10267. Improvements in electrodes for galvanic batteries. Carl Hoepfner, 45, Southampton-buildings, Chancery-lane, London.

10272. Improvements in dynamo-electric machines. Haydn Thies Harrison, 46, Lincoln's inn-fields, London.

MAY 14.

10284. A new and improved reflector in connection with glass bulbs or glow lamps for electrical lighting. George William Pridmore, Thomas John Sturgeon, and Edwin Yorke, 2, Broad-street-buildings, Liverpool-street, London.

10349. A process of preparing metals for galvanic, electrolytic, and for other purposes. Alexander Melville Clark, 53, Chancery-lane, London.

10358. An improved system for registering or storing electric currents and for reconstituting and delivering the currents so stored. Henri Carbonnelle, 6, Lord-street, Liverpool.

MAY 15.

10414. Improvements in electric hoists. William Harding Scott, Gothic Works, Thorpe Hamlet, Norwich,

10415. Dynamo-electrical collecting apparatus. William Sillery, 7 Henblas-street, Wrexham.

10429. Improvements in holders for electric glow lamps. Thomas Richard Davis Kenny, Sunbridge-chambers, Bradford.

10442. Improvements in arc lamps. William Reginald Ridings, 76, Alexandra-road, Edgbaston, Birmingham.

10455. Improvements in electric motors. Richard Norman, 14, The Goffs, Eastbourne.

10456. Improvements in electric motors and their arrangement. Richard Norman, 14 The Goffs, Eastbourne.

10472. An improvement in active material for secondary voltaic batteries. George Annesley Grindle, 28, Southampton-buildings, Chancery-lane, London.

10497. Improvements in or relating to electric traction. John Perry and Thomas Tomlinson, 322, High Holborn, London.

MAY 16.

10608 An improvement in tumbler electric switches. The Edison and Swan United Electric Light Company, Limited, and Charles Faraday Proctor, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1891.

4757 Electric reduction of aluminium, etc. Willson. (Third edition.)

1895.

1587. Electrical clocks, etc. Hope-Jones and Bowell.

8904. Battery plates. Menges

10895. Electric light standard. Stegmann.

11801. Electric incandescent lamp reflectors. Darrah.

18318. Suspending arc lamps, etc. Adams.

1896.

2382. Dynamometers. Lake. (Lewin.)

4234 Electric lamps for vehicles. Zimmerman.

4788. Electric battery, etc. Jacques.

5412. Telephones. McKenna. (Webb.)

6305. Electric railways. Hull.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-6½
Brush Company, Ordinary	3	1½-1⅝
—— Non. Cum., 6 per cent. Pref.	2	1⅝-1¾
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	8-8½
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7½-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16½-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14⅜-15½
County of London and Brush Provincial Co., Ordinary	10	8½-9½
—— 6 per cent. Cum. Pref.	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1½-1⅝
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	1½-1⅝
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	⅝-¾
Elmore's Wire Company	2	2-2½
Fowler-Waring Cables	—	—
W. T. Henley's Telegraph Works, Ordinary	10	16-17
—— 7 per cent. Preference	10	17-18
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	3⅜-3½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	23½-24½
—— 4½ per cent. Debentures	100	—
Kensington and Knightsbridge Ordinary	5	9-9½
—— 6 per cent. Pref.	5	7½-7⅝
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	17½-17⅝
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	1-1½
Metropolitan Electric Supply	10	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7⅜-7⅝
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅝-6¾
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	9-9½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4⅜-5½
St. James's and Pall Mall, Ordinary	5	10½-11
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	6	8½-8¾
Westminster Electric Supply, Ordinary	5	9½-10
Yorkshire House-to-House	5	7½-8

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NOTES.

Society of Arts.—The conversazione of the Society of Arts has been fixed for June 17 at the South Kensington Museum.

Prof. Elihu Thomson.—We are sorry to see from an American paper that Prof. Elihu Thomson has got thrown off a bicycle and broken his ankle.

Reade Lecture.—The Reade lecture at Cambridge on June 10 is to be delivered by Prof. Thomson, and will be on the subject of the "Röntgen Rays."

Another Exhibition.—There is to be an exhibition in Lisbon next year in celebration of the fourth centenary of the discovery by the Portuguese of the Cape route to India.

Royal Institution.—It is announced that there will be an extra Friday evening meeting of the members of the Royal Institution on June 19, when Mr. Thomas C. Martin, of New York, American delegate to the Kelvin jubilee, will deliver a lecture on "The Utilisation of Niagara" (with illustrations).

Dublin Tramways.—Last week in shunting a Ballsbridge electric tramcar over from one line to the other at the corner of Haddington-road, Dublin, where the system joins that of the Dublin United Tramway Company, the trolley jammed, but nothing worse occurred than a small amount of damage to the trolley and wire, and a temporary block.

New Use for Rontgen Rays.—According to the New York *Electrical World*, Dr. J. C. Perry and Mr. W. C. Cheney, superintendent of the Portland General Electric Company, have been very successful in defining free gold in quartz by means of Röntgen rays. If this is so, it is evident that the definition of "visible gold" will have to be enlarged and the mining prospector will be worried with another new test.

City and Guilds of London Institute.—An exhibition of the work done by students of the technological classes in connection with the City and Guilds of London Institute has been opened at the Imperial Institute. Sir Frederick Abel, in performing the opening ceremony, remarked that the rapid development of the operations of the institute showed that the country was waiting for the the work which the City and Guilds undertook.

The National Swiss Exhibition.—It is stated that the Lord Mayor and Sheriffs of London, in a cordial reply to the President of the Administrative Council of the city of Geneva, have conveyed their pleasure at receiving the invitation to visit the National Swiss Exhibition at Geneva. They, however, fear that it will be impossible for them to visit the exhibition together, though they hope to arrange, while on the Continent during the summer, to attend individually some of the *fêtes*.

Proposed Pacific Cable.—Sir M. Boyle, Mr. Sandford Fleming, and Sir Donald Smith, who have been appointed to represent Canada at the forthcoming conference on the subject of direct cable communication between England and her Australasian colonies *vid* Canada and the Pacific Ocean, have arrived in England, and called at the Colonial Office. The arrangements for the conference are not yet completed, but it is officially stated that the preliminary meeting of the Commissioners will be held shortly.

The Paris Telephone.—M. Boucher, the French Minister of Posts and Telegraphs, having arrived at an understanding on the subject with the British postal authorities, has decided to establish four fresh telephone wires between Paris and London. This step will be effected without cost to the French Exchequer, as the corporation of the Paris stockbrokers has undertaken to advance the sum of about £26,000, the cost of the aerial lines in French territory and half the cost of the cable across the Channel, the corporation to recoup itself out of the receipts.

Magnetic Crane.—An electromagnetic crane has proved itself very convenient at Woolwich Arsenal in lifting and carrying shot and shell, which, owing to their peculiar shape, are somewhat difficult to handle, their removal formerly occupying much time and trouble. The electromagnet is a solid forging, with a concave-curved base so as to fit on to the projectiles. The wire of the coils round the magnet is mechanically protected by heavy brass flanges and stays. The current used varies from three to four amperes at 26 to 30 volts. The switchboard is on the counter-weights at the back of the crane.

Motorcarts in Court.—It is not yet safe to use a motorcart in London. An electric carriage was caught by a policeman going down Parliament-street at half-past three in the afternoon, at the rate of about five miles an hour, and without any person preceding it to give warning of its approach. On the driver being summoned to Bow-street Police Court to explain to Sir John Bridge what he meant by it, the driver's only excuse was that he had done it before in the aggregate to the extent of about four or five thousand miles. He promised never to do so again—at least we suppose not till the Act gets passed—and was promptly fined 40s. and costs.

Telegraphic Interruptions.—The Berne *Journal Télégraphique* of May 25, in its list of interruptions for the previous month, states that communications are restored over the Nicaraguan land lines after having been interrupted since February 26. Under the head of communications not yet re-established, when the list was compiled, come the Ceara-Maranham cable, interrupted from April 28; the San Thomas-Loanda cable, from May 2; and the Amazon Company line beyond Monte Alegre, from May 2; while the Rhodesia troubles are represented by interrupted communication between Gwelo, Fontesvilla, and Beira since April 2. Except the old-standing ones, such as the Brest-St. Pierre cables, the rest were interruptions of only a brief duration.

Institution of Electrical Engineers.—We have the *Journal* of the Institution of Electrical Engineers covering the proceedings up to the end of March last. It may be a small thing, but it is worth noting that there has been a decided improvement in the way in which the *Journal* is put up for sending out, and the edges of the book are no longer cut and damaged by the string used to secure the cover. Of 27 abstracts no less than 11 relate to the subject of the Röntgen radiations. A meeting of members only has been called for four o'clock to-day (Friday), at 28, Victoria-street, S.W., for the discussion of business connected with the Institution. As we apprehend the circular convening the meeting to be a private one sent to members only, we have not felt at liberty to publish the resolutions which will be proposed.

Telegraphs in Africa.—After a break extending over six weeks telegraphic communication is once more established between Blantyre and the south. It appears that in Nyassaland the climate of the Zambesi valley and the difficulties of the country are not the only obstacles which the telegraphic engineer has to surmount, since this particular break in communication was due to a dispute between a Portuguese official, Lieutenant Correia, and the representative of the African Trans-Continental Company,

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Lieutenant Correia seizing the company's office and instruments at Tete. This action was dissented from by the Portuguese commandant at Tete, and Lieutenant Correia was recalled to Quilimane. Further south, towards Rhodesia, part of the line between Salisbury and Tete is still incomplete, but it is hoped that it will be completed now that the rainy season is over and more labour obtainable. Messages, however, are got through over the gap by a wire laid temporarily along the trees. Still further south there are, of course, the Matabele to be reckoned with.

The Southsea Accident.—The Portsmouth Electric Lighting Committee have received a report from Major Cardew, of the Board of Trade, relative to the recent accident in Middle-street, when a cabman named Foote was injured by an electric shock from a lamp column. Major Cardew reported that he had examined the column and switch and found them in perfect order, the explosion being due to an escape of gas. There was no electric leak, but the gas had escaped from a pipe, which was found to be broken in two, and passed through the ducts to the column. When the arc light was turned out and the incandescents switched on, the gas exploded and caused the accident. As, however, the injured man appeared to show signs of having not merely received a blow from a portion of the lamp column, but also to have sustained injuries such as might have had an electrical origin, the muscles of his right arm being contracted, Major Cardew laid the point before Lord Kelvin, who suggested that as flame was a conductor of electricity, the current might possibly have been communicated to the man in that way.

Motors for Sugar Works.—M. Désiré Korda, of the Compagnie de Fives-Lille, has contributed an article to the *Revue Generale des Sciences* on the employment of three phase current motors in sugar works. The centrifugal separators used in works of this kind go at from 600 to 1,500 revolutions a minute. The mass is considerable, and the axis of revolution vertical. It will be seen at once that a complete balance is important, and that a direct-coupled motor gives a more suitable method of driving than any possible arrangement of belts or gearing. Moreover, there are frequent stoppages, so that three-phase machines which have no commutators to spark are preferable to direct-current motors. An interesting example is the application of three-phase motors to Huebner centrifugals, which require to be capable of being driven at two speeds—say of either 500 or 1,000 revolutions a minute. This might be done either by doubling the number of poles on the motor or doubling the frequency of the alternations. The latter system involves two sets of generators and plant, but it is the one that has been for various reasons adopted at the Abbeville Sugar Works and the Sommier Refinery.

A Street Railway Strike.—The *Western Electrician* (Chicago) gives some details of a strike of about a thousand motormen and conductors in the employ of the Milwaukee Street Railway Company, by which the service of the cars in that city was for the first time in its history stopped The demands of the strikers were for more pay, rearrangement of hours, a recognition of their union, all of which are of the usual character, but the last one is peculiar—namely, permission to order and purchase uniforms for themselves from any tailors they choose. The City Council interposed with a mediation committee, but as it at the same time proceeded to discuss resolutions for revoking the company's "franchise" and acquiring "by purchase or condemnation" the tramway system, its impartiality was naturally somewhat under suspicion, and it is not surprising that its efforts in the direction of conciliation were a complete failure. Meanwhile, the company imported workmen from other cities, and according to the latest reports had succeeded in running about two-thirds of the average number of cars, in spite of the usual obstructions in the way of stones, crowding, and blocked switches.

The Kelvin Jubilee. — The programme of the approaching celebrations of the jubilee of Lord Kelvin as Professor of Natural Philosophy in the University of Glasgow has been given in *Nature*. On the evening of Monday, June 15, at 8.30 p.m., the university will give a conversazione, when there will be an exhibit of Lord Kelvin's inventions. On Tuesday, June 16, addresses will be presented to Lord Kelvin by delegates from home and foreign university bodies, from several of the learned societies of which he is a member, from student delegates from other universities, and from the students and graduates of the University of Glasgow. It is expected that the honorary degree of LL.D. will be conferred on the same day on several of the distinguished foreign visitors. On Tuesday evening, June 16, the city will give a banquet to Lord Kelvin, to which the visitors who have come to do him honour have been invited. On Wednesday, June 17, the senate of the university will invite the visitors of the university staff to sail down the Clyde. The students of the university also invite the student delegates from other universities to a similar trip. Representative scientific men—about 50 in number—from America and the British Colonies, and from all the European countries, and about 150 from the United Kingdom have signified their intention to be present.

Telephoning the Paris Opera.—On the evening of the 21st inst., with the co-operation of the British and French postal officials, the experiment was tried of bringing the music of Mr. Duvernoy's new opera, "Hellé," then being performed at the Grand Opéra, Paris, over the telephone, so that it could be heard through the electrophone at Pelican House, London. The co-operation of the weather, however, could not also be secured, and a storm, worse in France than in England, played havoc with carefully-prepared arrangements, so that perfect communication could be established no further than Calais. The visitors invited had therefore to be satisfied with selections from the London theatres. A second attempt was made last Friday, and this time it succeeded. The sound, it is true, was rather faint, but the voices came out with delightful clearness, particularly that of M. Delmas and the tenor, M. Alvarez, who was singing for the last time in Paris prior to his visit to Covent Garden. The female voices were not quite so distinct, nor were the violins of the orchestra very audible, but the brass instruments made themselves evident, as is their custom, while a phrase for oboe came over the wires with great clearness. Only about a dozen scientific and musical people were present. After a certain amount of "Hellé," the electrophone was put on to comic opera, but, apparently resenting the degradation, did not seem to perform so well.

An Arabian Thunderstorm.—It is currently believed that it never rains at Aden, though more careful and accurate residents there say "only once in five years." But it appears that the climate is changing. In view of the water-tanks built by the Government, that is kind of the climate. The telephone and telegraph people there, however, do not like the change. At the end of last month there was a regular thunderstorm, and it seems to have proved altogether too much for them. "It was so dark that the electric light had to be used in the office of the Eastern Telegraph Company. The cables were much affected, and the work somewhat delayed. The telephones, too, were disturbed, and the captain of the Aden troop, wishing to speak to the general's aide-de-camp

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at the Residency, suddenly received a shock. The A.D.C., who was listening, said he, too, felt as if he had a violent blow in the chest, and declined to go near the instrument for some time. The manager of the new bank suffered still more; he was holding the receiver to his ear, and received such a shock that he could not use his hand for over an hour. In the E.T.C. superintendent's bungalow a flash of lightning seemed to light up all the wires, and rang the telephone bell." As it is hardly probable that an Arabian thunderstorm would specially select telephones as the subject of its attentions, these little difficulties will doubtless be got over in time at Aden, as they have been elsewhere.

High-Voltage Lamps.—In its issues of May 14 and May 21 the *Elektrotechnischer Anzeiger* devotes two articles to Mr. G. L. Addenbrooke's paper on "High-Voltage Lamps" at the Institution of Electrical Engineers and the discussion which followed. Our contemporary does not seem altogether satisfied on the question of the advisability of adopting a 200-volt system. At any rate, after emphasising the necessity on double-voltage systems of installing arc lamps in groups of not less than four or five lamps each, even though only two may be required, or, in the alternative of putting in a smaller number, having to pay just the same for the energy wasted in resistances, the second article, which is signed by Mr. F. Grünwald, comes to the point with a comparison of the cost of using high-voltage lamps or high-efficiency lamps at 110 volts. By assuming an efficiency of four watts per candle for the high-voltage lamp and 2½ watts for the 110-volt one, and making the amount of copper conductor per lamp small enough, there is no great difficulty in showing an advantage in using the lower voltage. But, unfortunately, the 2½-watt lamp is a thing that is much more talked about than seen. However, in spite of its comparison of cost, our contemporary's conclusion is not to condemn the double voltage altogether, but only that "the four-watt lamp for 220 volts is a makeshift," and that the aim of the lamp manufacturers should be to produce a better efficiency and longer life.

Electric Turret Gear.—In its "Naval Intelligence," the *Times* has remarked on the number of foreign warships which are now fitted with both electric and hand gear for the movement of turrets and guns and the working of ammunition hoists. The latest addition to the number of these is the "Emperador Carlos V." armoured cruiser, launched in 1895, and now being pushed forward to completion at Cadiz. This vessel carries two 11in. Hontoria guns, forged and built at Creusot, in revolving turrets, one fore and the other aft, as her principal armament. The vertical movement of the guns is effected by means of a hand-winch, but the Forges et Chantiers de la Méditerranée are supplying electric gear for the working of the hoists and the revolution of the turrets. The electric apparatus is beneath the armoured deck, and is operated by a switch from the turret; but, in case of failure, both the hoist and the turret can be worked by hand. A like arrangement has been fitted by the same company in the Danish armoured gunvessel "Skjold," which is in progress at Copenhagen. The "Capitan Prat," built for the Chilian Government at La Seyne, was the first warship to attract attention by the application of electricity to the movement of her guns, and it will be remembered that a description of the apparatus appeared in this journal some time back. Subsequently, in the French service, the system has been applied in the "Jauréguiberry" and "Saint Louis" battleships; the "Latouche-Tréville" and "Pothuau" armoured cruisers; and similar gear is fitted in the "D'Entrecasteaux," first-class cruiser, now under construction at La Seyne.

Metric Screw Threads.—Attention has been called in *Cassier's Magazine* to the fact that up to the present the metric system has failed to meet the requirements of machine-shop practice in so far as concerns the providing of a convenient system of screw threads. Numerous attempts to devise metrical screw-thread systems have been made, but no one of these has thus far met with sufficient approval to secure general adoption. It is very much easier to adopt a new system than it is to throw away an old one, and hence each attempt to improve the metrical screw-thread systems has simply resulted in the addition of one more to the existing list without superseding any of the preceding ones. Thus there are in France the systems of the French navy, of the Chemin de Fer du Nord, of the Paris-Lyons Mediterranée Railroad, and those of Armengaud and of Cail. In Switzerland there are the systems of Reishauer and Bluntschli, and of Bodmer; in Germany, the two systems of Ducommun, that of the Engineering Society of Mulhausen, the system of the Pfalz-Saarbruck Society, that of Redtenbacher, and the two systems of Delisle, the latter one of which has also been adopted by the Society of German Engineers. There are thus no fewer than 14 different metrical screw-thread systems, no two of which will interchange. The difficulty appears to consist in the fact that the decimal subdivisions or multiples of the millimetre do not give sizes which conform to the mechanical requirements of strength, wearing capacity, and convenience of angle, while the introduction of other than decimal fractions is supposed at once to take any system out of the pale of metric orthodoxy.

The Jacques Cell.—Some time ago we gave an account of the carbon-consuming primary battery invented by Dr. W. W. Jacques, of Boston, in which it will be remembered the carbon is immersed in caustic soda maintained at a temperature of 800deg. F., or over, and traversed by a continuous supply of air bubbles, the whole being contained in an iron pot, which forms the other terminal, and which is surrounded by a closed furnace to maintain the temperature. At the time no figures at all were available as to the performance claimed for this somewhat eccentric-looking arrangement. It appears, however, that Dr. Jacques has had a 100-cell battery of this type in operation for experimental purposes for the last six months or so, the cells of which consist of iron pots 12in. deep and 1½in. in diameter. What is claimed for the battery had better be given as printed by our contemporary and namesake, the New York *Electrical Engineer*—namely, that "In a recent test made by Messrs. Stone and Webster, of Boston, the apparatus maintained 30 16-c.p. lamps at full brilliancy. It was found that to maintain these lights for 18¾ hours required the consumption in the pots by oxidation of about 8lb. of carbon. The average pressure during the test from the 100 cells was 90 volts and the current 16 amperes. Messrs. Stone and Webster report that the electrical energy actually obtained from the carbon consumed in the pots was 82 per cent. of the theoretical." These figures are curious enough without any statement of the amount of coal burned in the furnace to keep the soda hot, or, which is altogether a minor matter, the proportion of the current generated which is required to work the electrical pump used to drive the air through the electrolyte.

Electric Light from the Waterworks.—It has been pointed out many times that power for a small installation may advantageously be obtained from the natural enemy of electric lighting—the gas company—by means of a gas-engine. In France, however, they have gone so far as to propose to fall back on the waterworks when the power required is very small. At any rate, a

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correspondent has written to *L'Etincelle Electrique* to enquire why the water supplied under pressure by a town waterworks cannot be used to generate electric current by means of a turbine and dynamo. It may be noted, in passing, that the tiny turbine actuated by the town water supply has long been a foible of our neighbours across the Channel. The answer of our contemporary is, of course, that if you cannot get current from any other source, even a primary battery would in most cases be cheaper. The cost of current from a battery is put at from 2s. 5d. to 5s. 9d. per unit—we should much like to see the authority for the lower price. In France water is supplied at so much per cubic metre, and in the metric system the price and pressure—*i.e.*, "head"—required to compete with these prices would be easily calculated were it not for the fact that the efficiency of the turbine and dynamo come in. These being small, their efficiency is put at 60 per cent. and 70 per cent. respectively—*i.e.*, a total of 42 per cent. Of course quite a table of results may be brought out by varying the assumed prices and pressure, but the general conclusion attained is that with water at five centimes (less than ½d.) per cubic metre, which is the lowest price assumed, the water power would come into competition with the battery as soon as a pressure of a 10 metre or 32½ft. head is available. It is obvious that as the price increases so does the pressure required. In conclusion, Mr. E. Rivaud, who is responsible for the article in *L'Etincelle*, considers that there are cases where the small turbine and dynamo would be preferable to a battery, as where the price is approximately the same such an arrangement would be more convenient in use.

The Bedford Accident.—The inquest on the death of Albert Edward Christmas, who was also known by the name of Bates, has taken place, and terminated in a verdict of accidental death. It appeared that the deceased was working, with another man named Tacchi, at the St. Mary's transformer sub-station of the Bedford Corporation electric lighting system, both men being under the direction of a foreman named English. The last-named took the fuses, which were made of copper wire, out of the fuse-box in order to make the transformer "dead." Indiarubber gloves were provided, but on this particular occasion he did not use them. English told Tacchi and deceased to lift the fuse-box off the transformer cover. They proceeded to do so, and English, after having taken out the fuses, held the high-tension mains clear for them so as to allow them to get the box down. Deceased and his fellow-workman Tacchi commenced to lower the box, and had got it down about 8in., when the two men received a shock, Tacchi falling down on one side and deceased on the other. Tacchi fainted, and in a short time, about a minute or less, recovered, but deceased remained on the ground, lying on his back. English believes that he was not at that time dead, though he did not live more than three minutes. On examination there was found to be a small hole in the insulation of the high-tension cable. On this point evidence was given by Mr. Hope-Johnstone, the engineer of the Corporation electric lighting works. It was his opinion that the accident had been caused by the flaw in the insulation of the high-tension cable. The insulation was torn, looking as if it had fallen on something. He believed that the flaw was not there when the cable was first laid down. All cables were tested under water, after 24 hours' immersion at the manufacturer's works. They were tested again after the cable was laid down, before being brought into use. It is curious to note that, so far as can be seen, the circumstances under which Christmas and Tacchi received the shock were as nearly as possible the same—in the one case the result was immediate death, while in the other there was little or no permanent injury. It should be added that artificial respiration was tried in the case of Christmas under favourable circumstances, a medical man being on the spot almost immediately, but, as will be seen, it was without effect.

University of London.—We noticed last week three letters which appeared in the *Times* from Drs. Collins and Napier and Sir George Young on the subject of the reorganisation of the University of London. These letters have naturally called forth a reply from Dr. Silvanus Thompson, which takes up the best part of a *Times* column. "Dr. Collins and Dr. Napier," he says, "once more trot out their statistics of that notorious business of the circulars by which, under pretence that they were making the enquiry on behalf of the Lord President of the Council, they deluded some 1,800 of the graduates into signing certain postcard replies to questions so ingeniously framed that any reply, whether affirmative or negative, would commit the answerer to a position of hostility to the scheme of reconstruction as proposed by the Cowper Commission. As to the morality of sending out those circulars in envelopes marked like official documents of Convocation, the less said the better. They have had their reward—a paper triumph which on analysis is destitute of weight. Though we know the extraordinary efforts and the specious arguments used to extract this vote, to this day we do not know who the 1,800 graduates are, nor what means they possess of coming to a sound judgment on the real issues involved. On the other hand, we know that by increasing majorities, and by a decisive majority of the graduates best able to enter into the issues, Convocation has, in the only legal way open to it under the charter, pronounced in favour of a reconstruction in general conformity with the scheme of the Cowper Commission." On the subject of different examinations for resident and non-resident students, Dr. Thompson points out that a hard-and-fast rule is impossible. "Anyone acquainted from inside with the working of the higher education must recognise that what may be quite right in one faculty may not be good in another. In a subject like mathematics there may be no valid reason for giving to a non-collegiate student any different examination from that given to a collegiate student. But there are subjects in which this is not so. Consider the case of subjects like physics and chemistry, in which the collegiate training is mainly carried on in elaborately-equipped laboratories, and necessarily differs from any training which a private student can possible acquire on his own resources. The educational interests of both classes of students here demand separate examinations; for the external students would be at a serious disadvantage in entering an examination based on the training of the laboratory, and the internal students would be very unfairly treated if compelled to work for an examination that ignored the laboratory training." Dr. Thompson urges that the decision on such a point as this must be left to the senate to deal with *pro re nata*, and concludes by asking whether as the whole of the bodies concerned have now expressed their general agreement in the scheme of reconstitution, it is not time that Parliament should intervene, and, while giving the extremists of both sides every opportunity of being heard in the final adjustment, without delay appoint a tribunal to hear them, and carry out the long-delayed scheme.

The Telephone Company.—Two letters relating to the National Telephone Company which have appeared in the *Times* during the past week are not without interest in their way. The first is from Mr. George Barham, of Harrow, who wants "to caution landowners and occupiers against the vandalism of the National Telephone Company

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and their employés, which unless put a stop to will ruin the beauty of some of the prettiest roads in the kingdom." "On Saturday morning," says Mr. Barham, "on coming out of my house I observed six men, with three ladders, hacking and sawing branches, 10ft. and 12ft. long, and 4in. to 5in. in diameter, off well-grown trees which border the main road from London to Harrow. On being spoken to they refused to desist, saying they intended to carry out the orders of their foreman, who had obtained the permission of the 'gentleman.'" As Mr. Barham happened to be the "gentleman" — *i.e.*, the owner and occupier of the property—this tale did not work. Further damage was stopped, but "the branches cannot be restored, and two elm trees, an ash, and a well-grown chestnut have been irretrievably spoilt by the National Telephone Company. The loss is not mine only, for these very trees have been chosen by the artist to illustrate 'Picturesque Middlesex,' and are situate in the prettiest part of the Harrow-road. The Post Office authorities recently put a telegraph line along the same road, and sooner than injure the trees they asked permission to place a pole on the land at the back, to which I readily gave consent." Of course they did, for the Post Office knows well enough that even a Government monopoly does not carry the right of unlimited trespass, and when you want to make use of other people's property for your own convenience, the proper way—and in the end the best—is to ask permission in a civil manner. The second letter is from Mr. Faithfull Begg, M.P., who apparently having only just heard of Mr. Henniker Heaton's letter of April 23, wants to answer it. The answer is to the effect that Mr. Henniker Heaton does not know what he is talking about. "His references to the recent agreement between the Department and the National Telephone Company show that he is apparently ignorant both of its genesis and contents. The Department, having granted a license, desired to modify its terms. Hence they were under the necessity of negotiating, and have made the best bargain they could. The right to purchase in 1911 is not founded upon the new contract, but upon the original license." Mr. Begg makes one point neatly enough from a dialectical point of view. Mr. Henniker Heaton's description, he says, "of the Post Office as capable of giving a cheap and perfect system, sounds strange in the mouth of one whose life work appears to be to prove that of all the incompetent departments that ever existed the Post Office is the worst." But perhaps Mr. Henniker Heaton thinks that he and his friends in Parliament can do something to keep the Post Office in the way it should go, while they are quite powerless to put pressure on a private company. If so, that would be a good enough answer. In the last sentence, however, of his letter Mr. Begg ends by coming to at least a nominal agreement with his adversary. "My own opinion is that the Government should purchase, and should purchase now. Probably in that Mr. Henniker Heaton and I are in agreement." If the conclusion is the same in each case, why dispute as to the different ways in which it has been arrived at?

Magnetism at Low Temperatures. — Some interesting investigations on the effect of extremely low temperatures on the magnetic properties of iron and steel have been embodied in a paper by Profs. Dewar and Fleming which has been read at the Royal Society. Knitting-needle steel at various tempers, chromium, aluminium, and nickel steels, pure nickel, silicon steel, and soft and hard iron were experimented with, the samples tried being made up in the form of small needles about 15mm. (·6in.) long and magnetised to saturation. They were brought to temperatures as low as −185deg. C. by means of liquid air and tested in a reflecting magnetometer. Broadly speaking, the results obtained were: 1. That the sudden cooling to the temperature of liquid air usually permanently decreases the magnetic moment of short magnets made of many varieties of steel, assuming them to have been initially magnetised in a strong field. 2. This initial decrease is found both in hardened steels having great coercive force, and also in the same steels in a soft or annealed condition, and is especially conspicuous in the case of the 19 per cent. nickel steel. 3. In the case of most steels the effect of cooling magnets made of them to −185deg. C. is to temporarily increase the magnetic moment after the permanent magnetic condition has been reached. 4. The exceptions to the above rule are the nickel steel with percentages of nickel from 19 to 29 per cent., in which case the magnetic moment is always decreased temporarily by cooling to −185deg. C., after the permanent magnetic condition has been reached. 5. It appears that one of the best ways of ageing a permanent magnet is to dip it several times into liquid air. It then arrives at a constant condition in which subsequent temperature changes have a definite effect, and in which the sub-permanent magnetism is removed. In order to determine if similar changes of magnetic moment could be produced in the case of soft annealed iron, small magnets of Swedish iron were prepared, formed of a short length, about 15mm., of soft iron, or a small slip of annealed transformer iron. On magnetising these in a strong field, and testing them with the magnetometer, and cooling them by immersing in liquid air, it was found that the first effect of the cooling was to produce a small diminution in the magnetic moment, and the subsequent heating in some cases produced a further diminution of magnetic moment. In the first sample of soft iron, the wire was about 3cm. long, and bent into a U shape, with ends about 10mm. apart, and in this case the changes of magnetic moment were similar to those in the case of the carbon steels, only with very much narrower limits of variation. The first cooling hardly produced any change whatever in the magnetic moment of the magnet. On allowing it to heat up again, the magnetic moment was very slightly diminished, and thenceforth the changes of moment were such that the magnetic moment was greater when the magnet was cold than when it was warm, by about 2 or 3 per cent. of the latter value. In the case of a straight soft-iron magnet formed of annealed transformer iron, the curious fact was noticed that whereas a rapid cooling of the magnet by plunging into liquid air hardly produced any effect on the magnetic moment after the first initial loss of magnetism had taken place on cooling, the effect of a slow cooling down to the temperature of −185deg. C. was always to produce a permanent diminution of magnetic moment. Hence the magnetism of this soft-iron sample could be frittered away by a process of slow cooling to −185deg. C., and intermediate heating up to 50deg. C. A sample of the same iron, hardened by hammering, was tested, and was found to behave in a very similar manner to the glass-hard carbon steel, the changes in magnetic moment being relatively about the same percentage for the same temperature change—that is to say, the magnet had a moment of about 10 per cent. greater at −185deg. C. than at 5deg. C. Since a 19 per cent. nickel steel magnet increased in magnetic moment when heated from −185deg. C. to +5deg. C., and since it is well known that at some higher temperature it would lose its magnetism altogether, it follows that there must be a temperature at which it would have its maximum magnetic moment. After repeated heatings and coolings this temperature was found to be about 56deg. C.

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CABLE-LAYING ON THE AMAZON RIVER.*

BY ALEXANDER SIEMENS, M.I.C.E., M.I.E.E.

When it had been decided to connect Belem, the capital of the State of Pará, by means of a subfluvial cable with Manaos, the capital of the State of Amazonas, a preliminary journey became necessary, during which landing places at the various intermediate stations had to be selected. As no reliable charts exist, some reaches of the river had to be explored, and various other details ascertained in order to facilicate the laying of the cable. This preliminary survey took place in October of last year during the hottest season, when the river was at its lowest, while the cable was laid during January and February of this year, when the rainy season had commenced and the river was rising. The difference in temperature between the two journeys was on the average not more than about 5½deg. C. (10deg. F.), but a great advantage during the laying was the almost continuous presence of clouds, which mitigated the fierce heat of the sun and kept the temperature at a very pleasant level. The diagram (Fig. 1) shows the curves of the variation in temperature during the cable-laying expedition, and gives the daily maximum and minimum temperature registered by a thermometer hung up under the officers' bridge in the open air, but sheltered from the sun. The third curve represents the temperature of the water, which was measured by a thermometer on the refrigerating machine fixed at a point where the water pumped in from outside first enters the machine. Besides the date, the places where the observations were taken are marked on the diagram, and it will at once be noticed how very equable the temperature was on the main river. The fluctuations in the air temperature are mostly indicating the absence or presence of clouds, but the water temperature remained perfectly constant during the whole time that the ship spent on the upper reaches of the river. The proximity of the sea lowers the temperature only to a small extent, as is clearly shown by these curves. A glance at the map of South America explains without much comment how immense the volume of water must be which is collected from an area measuring more than 2½ million square miles, for the most part covered with dense forests; and it follows that the temperature of such a body of water cannot be seriously affected by the daily variations of temperature indicated by the first two curves. It is extremely difficult to realise the true proportions of this river, but the comparative table, in which the dimensions of the principal rivers of the various continents are contrasted with those of the Amazon, will help to show the importance of this great system of natural waterways. With several other large rivers, the Amazon shares the fate that its name changes several times during its long course, and that at various times different affluents have been considered to be the true source of the main stream. Most geographers, however, regard the Marañon as the principal river, a branch of which, called Tunguragua, rises in Lake Lauricocha, in Peru, in 10deg. 30min. S. lat. and 76deg. 10min. W. long.; although the Ucayale, where it unites with the Marañon at Nauta (4deg. S. lat., 73deg. W. long.), is quite as important as the Marañon. If the greatest distance from the mouth is to decide the question, then the source of the Apurimac, an affluent of the Ucayale, can lay claim to being the origin of the Amazon, rising in Peru in 16deg. S. lat. and 72deg. W. long. From the Lake Lauricocha the main direction of the Tunguragua and the Marañon is to the N.N.W. until the river turns eastward, and shortly after passing Jaen breaks through the Andes, entering the plains of the Amazon valley by the Falls of Manseriche a short distance west of Borja. Its further course is a little north of east until it pours its yellow waters into the Atlantic under the equator between the Cabo do Norte and

TABLE SHOWING DIMENSIONS OF PRINCIPAL RIVERS.

Name.	Length, in statute miles.	Watershed. Square miles.	Average discharge, cubic feet per second.	Length of navigable waters, in miles.
Mississippi (1)	2,616	1,285,300 (6)	675,000	35,000
La Plata..... ...	2,400	994,900 (6)	700,000 ?	20,000
St. Lawrence...	2,200	565,200 (6)	1,000,000 (7) ?	2,536
Nile.....	3,370	1,293,050 (6)	61,500	3,000 (3)
Volga	2,325	592,300 (6)	384,000 (2)	14,600
Danube	1,735	320,300 (6)	205,900	1,600 (3)
Rhine	810	32,600 (6)	—	550 (3)
Thames	210	6,010	2,220 (4)	200 (3)
Amazon (5) ...	2,730	2,229,900 (6)	2,400,000	50,000

(1) To source of Missouri 4,300 miles.
(2) At Saratoff.
(3) Exclusive of tributaries.
(4) At Teddington.
(5) To source of Apurimac 3,415 miles.
(6) According to Dr. John Murray.
(7) According to Darby, the American hydrographer.

Area of Great Britain and Ireland	120,626
Area of British India	1,560 160
Area of Brazil	3,219,000
Area of Europe	3,790,000

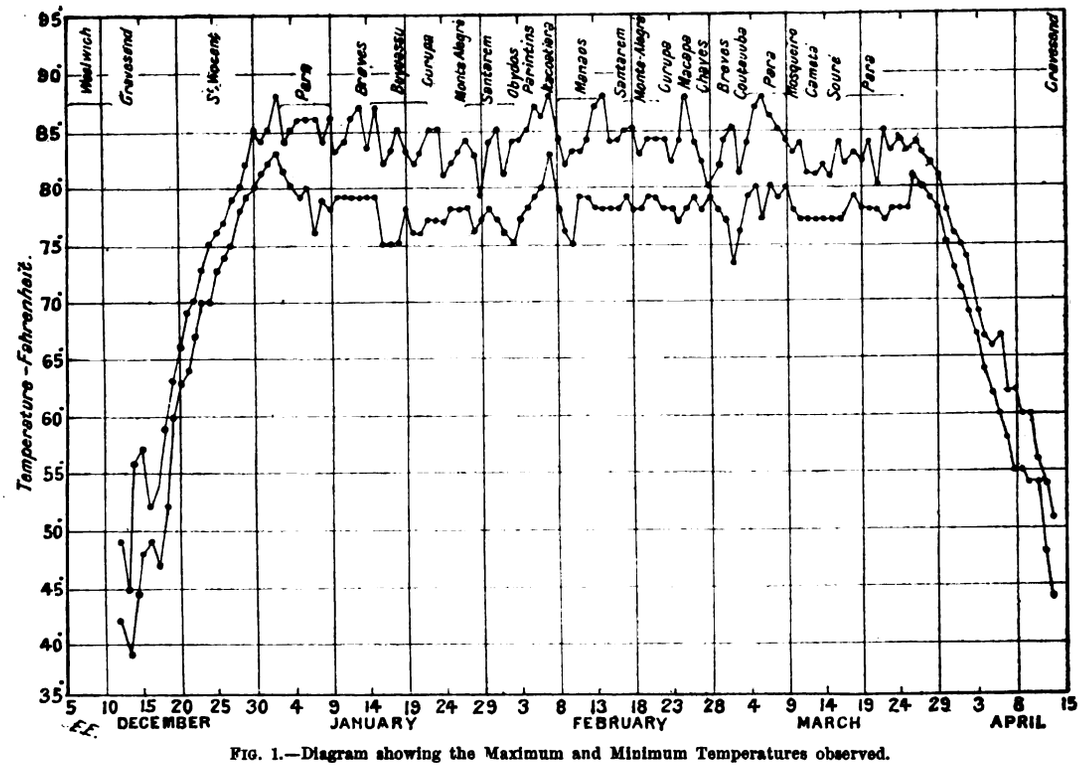

FIG. 1.—Diagram showing the Maximum and Minimum Temperatures observed.

* Paper read before the Royal Institution.

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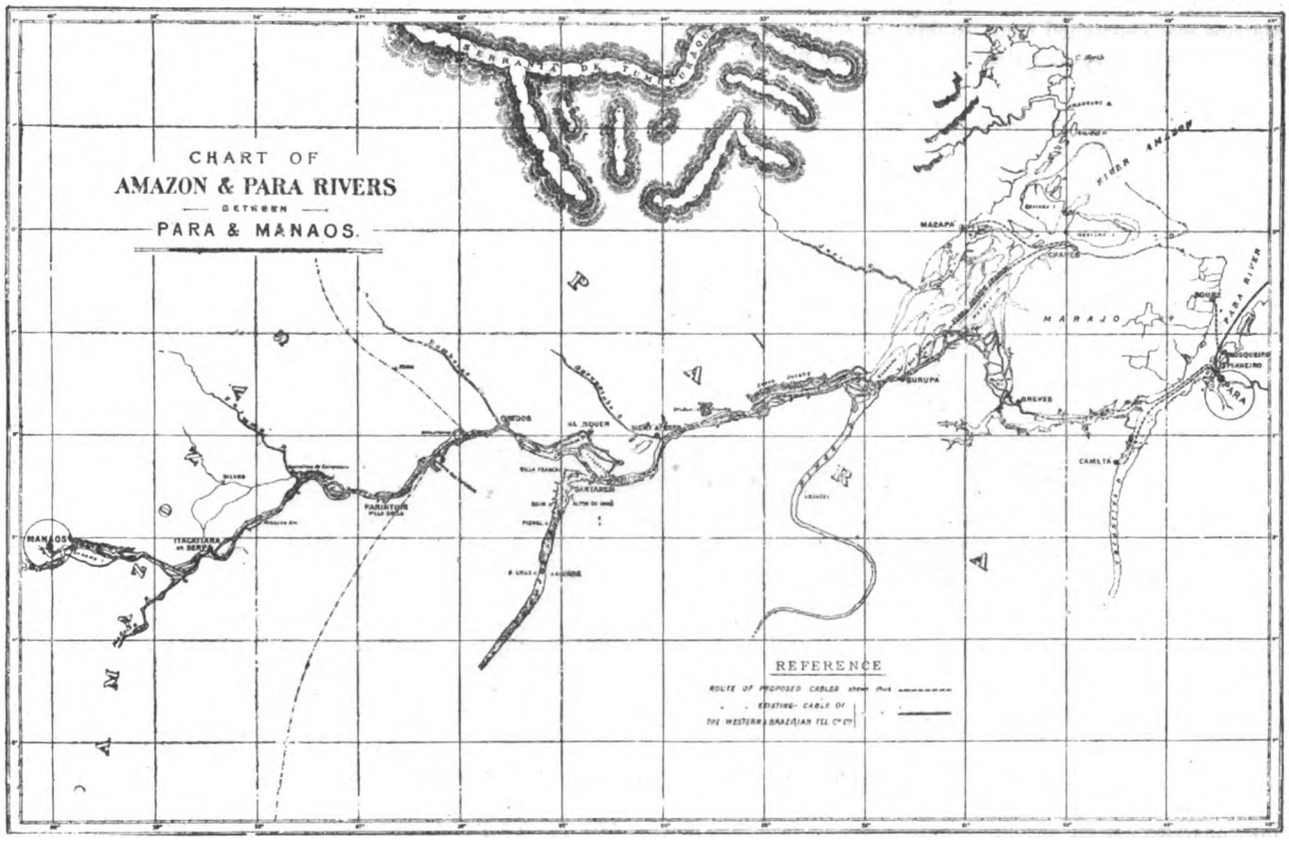
the Cabo Maguari, which are 158 miles apart. This distance is just about equal to the distance from Lands End to Cape Clear in Ireland, or from Brighton to Falmouth. Even west of the island of Caviana, which lies in the mouth of the river, together with the island of Mexiana and several smaller ones, the width of the main stream is over 50 miles, equal to the distance from Portland Bill to the Cap de la Hague. The part of the Amazon flowing north of the island of Marajó may therefore be compared in width to the Channel, but in depth and volume of water it far surpasses it. It is a disputed question whether the water flowing south of Marajó, commonly called the Pará River, should be considered as part of the Amazon or not. A network of natural canals, "the narrows," connects the two waterways west of Marajó, but the influence of the tide makes it difficult to decide whether part of the water of the Amazon finds its way south of Marajó or not. Along the whole course of the Amazon, commencing at the foot of the Andes, a similar network of islands and canals is formed on both sides of the river, as the whole country is almost level, and is consequently inundated during the rainy season for hundreds of miles by the rivers flowing



through it. The most notable exception to this general state of things occurs at Obidos, where the whole volume of water is compressed into one channel a little over a mile wide, and said to be about 40 fathoms in average depth. A sounding taken opposite Obidos, about a third of the distance across the river, showed a depth of 58 fathoms, measured by a steel wire and Sir William Thomson's sounding machine. As the current of the river averages three knots in the main channel, it is not easy to take soundings by an ordinary lead-line, and even with the steel wire an extra heavy weight (33lb.) has to be employed, or the results are not reliable. Besides the wire sounding machine, a submarine sentinel was used on the preliminary voyage wherever serious doubts existed about a channel through which the cable was to be laid. This apparatus consists of a small winch, from which a wire leads into the water and drags at a short distance behind a piece of wood, shaped like an angle iron, in a nearly upright position. The wire is not attached directly to the piece of wood, but to a string, kite fashion, and the wood is fitted with an iron foot, which, on coming in contact with the bottom of the water, releases one end of the kite string, so that the wood remains attached to the winch wire with one end only. The consequence is that the strain on the wire is suddenly reduced to a very small amount, and the piece of wood appears on the surface of the river. It depends on the quantity of wire paid out how deep the kite or the sentinel floats, and its action is quite reliable, so that it is unnecessary to take soundings by the line or by wire while the sentinel is being dragged by the ship. Usually the sentinel was set at five fathoms, and when it struck a bar the ship was stopped, and a series of soundings taken to ascertain the exact depth of water and the extent of the shallow place. A further difficulty in sounding originated from the soft nature of the soil, which, for the greater part of the Amazon valley, is alluvial clay, and allows the lead to sink into it for several feet. In the narrows there appears, however, a bank of hard clay, called *tabatinga*, which unfortunately blocks nearly all the branches of the narrows and creates bars all along the course of the Tajipuru, the main westerly waterway connecting to the Gurupá branch of the main river. Occasionally the same hard clay forms shallows in the main river, but as a rule the section of all the channels resembles the capital letter U—*i.e.*, the sides are very steep and the bottom flat. In this respect, as in many others, the Amazon differs entirely from the Indian rivers, which build up their beds above the surrounding country, occasionally breaking through their natural banks and seeking a new bed. The Amazon, on the other hand, carries with it only the light clay sediment which forms the soil of the whole valley, and the inducement for the main stream to alter its course is therefore very small, and long straight reaches are the result. Under these circumstances the largest vessels can ascend the river nearly to the foot of the Andes, but the constantly changing sandbanks at the mouth of the Amazon proper make this approach of the river dangerous, and the State of Pará is, for obvious reasons, not over-anxious to have the deep channels properly buoyed and surveyed. This forces all the shipping to enter the Pará River and to pass the narrows if the Amazon is the goal of the journey. In doing the latter, the choice for large ships lies between one of the channels (called *furos*) with a bar where it joins the Tajipuru and a *furo*, the Macajubim, which has plenty of water, but which winds about in such a serpentine fashion that only ships with twin screws can pass it unassisted. These difficulties are, however, much diminished during the rainy season, when the river rises to such an extent as to drive all the inhabitants of its banks into the towns which have been built wherever a natural eminence secured the inhabitants against the flood. Near the mouth the differ-

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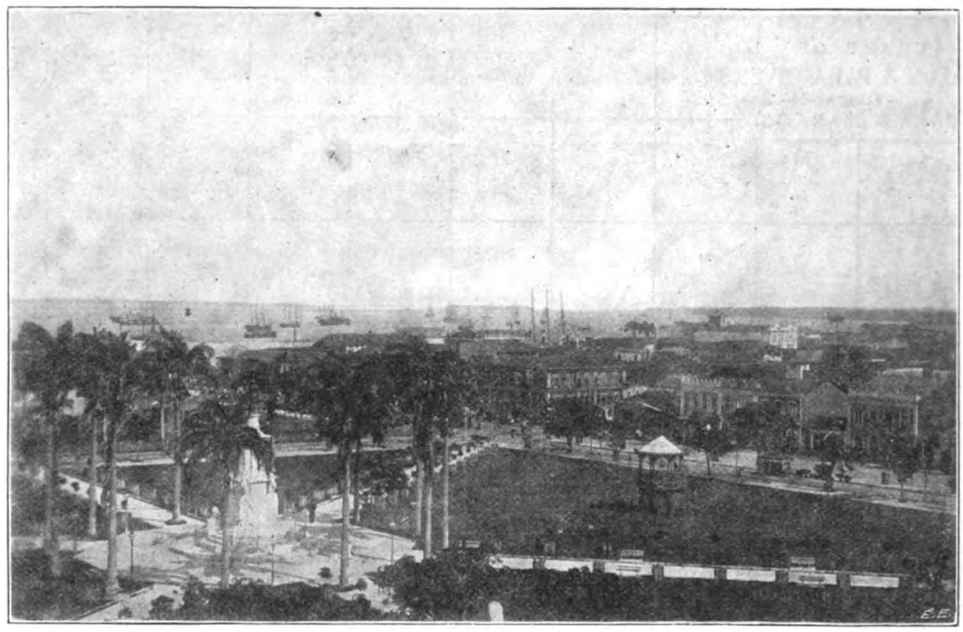
ence is naturally not so great as higher up, where the influence of the tide is felt less, but at Manaos the difference in level between low river and high river exceeds 40ft.

With all rivers carrying sediment, the Amazon shares the peculiarity that its immediate banks are higher than the country lying behind them, and thus we have in the rainy season the spectacle of the main river flowing between two banks covered with dense forest and immense lakes stretching out on either side of these banks. These do not entirely dry up during the remainder of the year, so that the whole of the Amazon valley really forms a huge swamp covered with a most luxuriant forest, which below Manaos narrows to a broad belt close to the main river with prairies, called *campos*, at the back of the forest stretching out to the hills, where the forest recommences. In such a country no land communication of any sort can be attempted, as the tropical vegetation and the annual inundations of the rivers destroy everything that man places in the way of the natural forces. By water, on the other hand, the intercourse between all habitable parts of the country is easy and expeditious since steamers have been introduced in the year 1853. At that time the journey from Belem to Manaos was shortened from 40 days to eight days, and at present the ocean-going steamers, which do not call at the intermediate places, accomplish the distance in three days. Belem, the capital of the State of Pará, lies on a branch of the Pará River, called Guajará, which unfortunately does not share the characteristic shape of the Amazon and the *furos*, but forms a rather shallow basin in front of the town. The general aspect of the town, but for the presence of palm trees, does not differ much from that of a European seaport. Even the clothing of a good many inhabitants seems better adapted to a colder climate; it is only the airy costume of the ladies, and still more the absence of any costume on the children, that betrays the tropical climate. The harbour of Pará is very full of shipping, and the general build of the steamers is well adapted to navigate the broad waterway of the main river as well as the smaller and shallower affluents, which become more and more inhabited from year to year. As the cable steamer could not approach close enough to Pará, the shore ends were laid with the help of a barge and a tug without anything occurring that need be mentioned. By the same means the sections from Pará to Pinheiro, and from there to Mosqueiro, were laid, the large steamer laying the section to Souré across the Pará River. These three places are much resorted to by the inhabitants of Pará for their healthy situation, and because they imagine that salt water reaches at least Souré. The views show how the forest encircles all the houses, but the proximity of the sea and the breeze blowing regularly every afternoon make all these places extremely comfortable. At Souré the ss. "Faraday" was anchored at a convenient distance from the shore, so that the shore end might be landed direct from the ship, and as long as the tide was rising this plan appeared excellent. By the receding tide, however, a whirlpool was formed with the ship lying right across the centre, and when it had been turned 17 times in one hour the captain was tired of it and moved the ship to a safer anchorage. Another branch of the cable was laid from Pará to Cametá, on the River Tocantins, which is 1,200 miles long, but unfortunately has some rapids not far from Cametá, which cut off the navigable upper portion of the river from direct communication with the general Amazon system. Cametá boasts of a fine old church and a number of two-storeyed buildings, indicating the prosperous state of the township.

The first station on the main cable is Breves, the centre of the rubber trade of the islands of the lower Amazon, situate in the centre of "the narrows." Between Pará and Breves there is only one shallow passage, near the light-house of Gujabal, and the pilot managed to run the ship aground there. Luckily it was low tide, and with the rising tide the ship could be turned. At Breves the ship was anchored close to the shore, and its stern secured to a tree by a rope so that the tide could not cause it to swing. Under these circumstances the landing of the shore ends was an easy matter and soon finished. The ship then resumed its way into the narrow *furos* described above, and the night did not put a stop to its progress, as the outlines of the forest were clearly visible against the sky and the water everywhere more than seven fathoms deep. While the speed of the ship was kept at about six knots, the pilot ordered the quartermaster to put the helm astarboard, as he wished to increase the distance between ship and shore. The quartermaster was, however, confused, and put the helm hard-a-port, with the result that the bows went into the forest until the branches of the trees touched the foreyard. To appreciate the situation, it should be mentioned that the foremast stands 74ft. abaft the bows, and that the foreyard is 69ft. above the water level. Luckily, the soft ground, the elasticity of the forest trees, and the steepness of the banks rendered this accident quite harmless, and on reversing the engines the ship at once came off, so that the laying could be resumed. Not far from this spot the Aturia *furo* branches off, through which the cable had to be laid, but which was impassable for the ss. "Faraday" on account of a two-fathom bar at the Tajipuru end of the *furo*. As a splice had to be made with some cable on a barge from which it was to be paid out through the Aturia *furo*, the "Faraday" had to be



The Harbour at Para, taken from the roof of the Governor's Palace.

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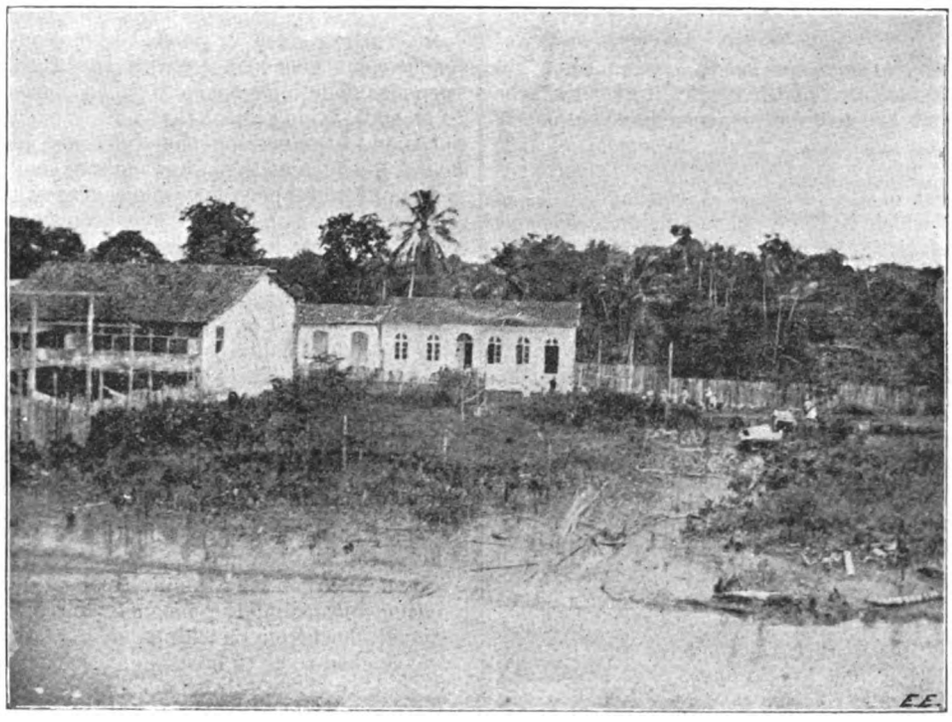
anchored, and the right-hand shore was approached so as to leave room for the ship to swing round when the tide turned. At the critical moment when the anchor was to be lowered, somebody blundered, and turned the electric light out, leaving the anchor winch and its surroundings in darkness. By the time this mistake had been rectified the ship was dangerously near the shore, and even the anchor could not sufficiently check its advance, so that it ran again ashore, stopping within about 5ft. of a house, much to the alarm of the inhabitants. This manœuvre fixed the ship in a most convenient position, so that it was left there until the splice had been finished and the tug "Cochrane," with the barge, had started laying the cable in the Aturia *furo*. Again there was no difficulty in backing the ship off the bank, but the *furo* proved to be too narrow to turn the ship, which had to return to Breves, or rather a few miles beyond to the mouth of the Boiuassu, in order to enter the *furo grande* and the Tajipuru in a roundabout way. As the ship was drawing over 24ft., and the bar at the end of the Boiuassu had only 23ft. of water at high tide, the result was easily foreseen, but the ship remained on the bar for nine days, by which time sufficient cable had been transferred to the barge and to the ss. "Malvern" to enable the ship to continue her journey. During this enforced sojourn in the midst of the most wonderful combination of islands and rivers, the two naturalists which the British Museum authorities had kindly sent with the expedition took full advantage of the opportunity to explore the locality in all directions.

Unfortunately, the time is too short to give many details of the intermediate stations, but their general aspect is very similar, and nothing noteworthy occurred at most of them. Commencing at the mouth of the river, the first station is Chaves, and the second Macapá; to these two places a branch is laid from Gurupá. The ss. "Faraday" had the distinction of being the first European steamer which has navigated the Amazon river below the mouth of the Tajipuru; in fact, neither the pilots nor the inhabitants knew of any foreign ship that had ever touched at these ports. In Gurupá, the second station of the main line, the inhabitants expressed their joy at being put in communication with the rest of the world by actively helping in the landing of the first shore end. A young lady in white, niece of the Mayor, borrowed a handkerchief from one of our engineers, daintily laid hold of the end of the cable, and triumphantly carried it into the station. Here a ball was started, and the happy couples waltzed round the cable-end to show their appreciation. Meantime, the tug began pulling on the barge from which the cable was to be paid out, and just as these vessels began to feel the current, which runs rather strong there, something jambed, the cable would not run out, and the tug could not hold the barge against the current. Barge, tug, and cable drifted down stream, the end gradually disappearing out of the station. This *contretemps* luckily did not disturb the dancers, who continued their rejoicings until the end had been brought back. Monte Alegre lies on a *furo* which, unfortunately, has a shallow bar at its mouth, so that the cable had to be laid in and out by the barge and tug. This *furo* is swarmed with "botos," a species of dolphin much coveted by the naturalists, but the natives do not try to catch them because they are neither good for food nor useful in other ways; besides they are remarkably shy and strong. From there the cable is laid to Santarem, at the mouth of the Tapajos, which presents a strong contrast to the Amazon on account of its clear waters and tranquil flow. This river is 1,200 miles long, and is formed by the union of the Arinos and Juruena, rising 14deg. 42min. S. lat. and 60deg. 43min. W. long., in the so-called *aguas vertentes* (the turning waters) close to the sources of some of the affluents of the Paraguay River. In the rainy season all these waters mix, and it is possible to pass in a boat from the mouth of the Rio de la Plata in 35deg. S. lat. to the mouth of the Orinoco in 10deg. N. lat. by way of the Paraguay, the Tapajos, the Amazon, the Rio Negro, and the Cassequiare, which forms a connecting link between the Amazon system and the Orinoco. From Santarem a branch cable is laid to Alemquer, and Obidos, the next station of the main line, is the last point touched in the State of Pará.



Typical Riverside View on the Amazon.

It would not be right to leave unnoticed the rubber-gathering industry, which is at once the wealth and the bane of this part of the world. The implements in use are of the most primitive kind, as may be judged by the samples on the table, but the average earnings can easily be £3 per day during the dry season, and the facility of earning so much money with little exertion makes the inhabitants unwilling to engage in more arduous labour. A narrow path leads from the hut on the water's edge into the forest from one rubber tree to another, the path eventually returning to the hut. The trees are cut on the morning round, and the rubber is gathered in the afternoon. As soon as it arrives at the hut a fire of oily palm nuts (Attalca excelsa) is lighted, and the thin sap thickened in the smoke. For this purpose a paddle is used on to which the sap is poured with a small earthenware or

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tin vessel. The smoke soon thickens it, and a new layer is poured on until the well-known flat cakes of indiarubber have been formed. Owing to the rise of the river during the rainy season most of the huts have to be abandoned, and it can easily be imagined how comfortless they are. Nearly all of them are built on piles, and most of them are thatched with palm leaves. There is hardly any attempt made to cultivate the soil, such as it is, but everything is imported. The ss. "Cametense," in which the surveying party went out, was laden with cabbages, onions, and potatoes, part of which went as far as Iquitos, in Peru. Chiefly owing to this want of provisions and to the generally careless mode of life, the mortality among indiarubber-gatherers is very great.

There are two stations in the State of Amazonas—Parentins, formerly called Villa Bella da Imperatriz, and Itacoatiara, formerly Serpa. Just before reaching the former station the Serra de Parentins is passed, which forms the boundary between the two states. At Parentins the river makes a sudden bend, and the resulting eddy-current greatly impeded the work; at Itacoatiara, on the other hand, the bow of the ship was run ashore and the end of the cable landed direct from the ship.

No words can describe the luxuriance of the vegetation met with everywhere on the journey better than has been done to perfection in the classical works of Bates and Wallace. Everything they have said in this respect remains as true as it was 40 years ago, and hardly anything new can be added to their description of the general features of the Amazon valley, but the town of Manaos has completely changed its character since it was made the capital of that region in 1853. A town quite European in its features has arisen in the midst of the forests, and to the benefits of rapid transport, to which it has owed so much, there is now added the characteristic lever of modern progress, the annihilator of space and time—electrical communication.

SINGLE-PHASE SELF-STARTING SYNCHRONOUS MOTORS.*

BY F. H. LEONARD, JR.

Every central-station manager who operates an alternating plant has to grapple with the question of power distribution. Applications for power service come in from every direction, and in many cases, properly worked up, would make a more remunerative business than that of furnishing current for lighting purposes. It is, perhaps, unnecessary to point out that the bulk of the lighting service averages but a few hours per day, whereas the motor service covers a much longer period with a corresponding reduction in cost of the current output. The difference is so great that many stations are furnishing current for motor service at 50 per cent. of the price for lighting service, and even at that figure the motor business is the more profitable.

The drawback to the single-phase synchronous motor has heretofore been that it could not be started without some other source of power, and would not carry its load up to speed. Motors are now made in which this is entirely overcome. They start up under load, and can be specially wound to give much greater torque in starting than when running in synchronism.

Two simple, well-known principles are combined in this motor: The principle of the ordinary alternating-current synchronous motor with that of the direct-current motor or generator. The armature has two distinct windings; one, a distributed winding connected to a commutator, similar to that of a direct-current motor or dynamo, which in this motor is used for starting and afterwards for exciting the field. The other winding is of the shuttle type, wound so as to concentrate distinct and regularly alternating poles in the armature, and performs the regular work of rotating the motor armature, advancing it from one pole to the next with each impulse of the generator.

An ordinary double-throw switch on top of the motor is used in starting, there being no resistance or other complicated device, as the self-induction of the windings is sufficient to choke back any abnormal flow of current. In starting, the switch handle is depressed so that the lead wires which conduct the alternating current from the transformers are connected through the switch blades to the contacts which lead the current first to one of the commutator brushes, thence through the distributed armature windings and out through the opposite brushes to a coarse wire winding on the field poles and back again to the switch contacts and binding posts, these connections being identical with those of a direct-current series motor. As soon as the current is turned on, the motor commences to rotate at a constantly accelerating speed until synchronism is reached, which is indicated by the lighting of a lamp located on the switch at a dull red. This is the signal for the reversal of the double-throw switch, which then changes the complexion so that the leads from the transformer are cut off from the commutator and connected to the collector rings and concentrated armature windings, while at the same instant the commutator brushes are connected to the shunt field windings, magnetising the field with direct current, the only office of the commutator after the motor is started and up to speed being to supply the small direct current necessary to magnetise the field.

In starting without load the motors will run up to synchronous speed in from 5 to 15 seconds, depending upon size, windings, etc., and when loaded in from 15 to 30 seconds, taking about the same current in either case, the time factor making the difference in the power consumed, the current taken under these conditions amounting to from 25 to 50 per cent. in excess of what the motor will require when running in synchronism. But when only required to start itself or light countershafting this current may be greatly reduced by special windings.

The direct-current winding delivers a perfectly smooth current, and is not at all pulsating in character. In circuit with the field winding is a rheostat to control the extent of field excitation. This rheostat is located in a recess in the base of the motor, the handle for its regulation being accessible through the oval opening at the commutator end pedestal. The motor, starting switch, and field rheostat are in one piece, making a most simple and compact combination. All that is necessary to instal the motor is to connect the secondary wiring of the transformer to two binding-posts on the motor, and it is ready for operation.

The field crown is of the multipolar type, with field cores pointing inwardly; the magnetic circuit is composed of sectional sheet-iron punchings, each section including two poles, stacked so as to break joints. These punchings interlock and are clamped between two cast-iron rings with bolts passing through from side to side, which serve to clamp the whole together solidly, at the same time holding each punching in its proper place and tying them like links in an endless chain. The bottoms of the cast-iron rings are milled to fit the base of the motor, to which they are firmly bolted.

On top of the field crown is placed a starting switch, and all the electrical connections from fields, commutator, and collector brushes are brought around the outside of the field punchings to the top, concealed from view, however, by the perforated steel jacket, which is held in place by grooves in the cast-iron clamping rings, forming an ornamental finish, and greatly increasing the radiating surface.

As this motor runs at a constant speed, it has been necessary to devise several arrangements to accomplish what might be done by variable speed motor. Motors are made for blowing church organs, in connection with which it has usually been customary to provide complicated automatic speed-regulating devices. With this motor no attempt has been made to vary the speed. The organist closes his circuit and starts his motor by means of a pedal. A blower, driven by the motor, fills the bellows and maintains a constant pressure, usually about 4oz. per square inch. If no air is used, the blower spills the wind out of its fan, and requires only enough power to overcome the friction and maintain the pressure. As fast as the air is used the blower takes a corresponding amount of power, the motor absorbing the current accordingly.

* Abstract of paper read before the National Electric Light Association. From the *Electrical Engineer* (New York).

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An arrangement for elevator service which is extremely simple has been devised. The constant-speed alternating motor, cable drum, and gearing are all mounted on a single base casting, in which the respective parts are bolted. There is a pinion on the shaft of the motor which engages two bevel gears, each mounted on a sleeve, which also carries one part of a friction clutch, the two sleeves rotating in opposite directions, and the whole being supported by and turning freely on the worm-shaft which engages the worm-wheel that turns the cable drum. The other part of each clutch is keyed to the worm-shaft. The controller wheel is mounted on an extension which is cast on the case that entirely encloses the bevel gears and pinion, permitting them to run constantly in oil. This controller wheel is connected to the controller cables or hand ropes which serve to operate the elevator. A pull on the hand rope turns the controller wheel, rotating it through an arc of 60deg. This rotation serves, first, to release the brake on the worm-shaft, by means of the adjustable link and lever, by depressing the roller which travels over the cam in the controller wheel; at the same time, one shipper fork is moved by the connecting rod at its upper end, which is pivoted near the upper rim of the controller wheel, far enough to cause one of its clutches to engage its other part on the sleeve attachment to the bevel gear, so as to drive the worm-shaft and rotate the cable drum. At the same time the connecting-rod attachment to the shipper fork opposite moves across the centre of the controller wheel without producing more than enough movement to take up the lost motion in the clutch parts to which it is attached. Pulling the hand rope in the opposite direction brings the parts back to their original position, disengages the clutch, and sets the brake on the worm-shaft. Pulling still further in this direction, the opposite connecting rod travels so as to move the shipper forks and engage its clutch, turning the hoisting drum in the opposite direction, while the first-mentioned connecting rod moves across the centre without causing any appreciable movement of the shipper fork. The motor runs continuously in one direction during working hours, and there is no heavy rush of current in starting as with a direct-current series motor, with its tendency to drop the brilliancy of the incandescent lights on the same circuit.

These motors are suited to any frequency in general use in this country, and are wound for from 140 to 60 complete periods per second, the speed being fixed by the frequency of the generator or circuit to which it is connected.

While this motor was designed for single-phase circuits, yet it is obvious that it will work quite as satisfactorily when connected to either leg of a two or three phase circuit, and where such circuits are loaded with induction motors, a few synchronous motors properly distributed and somewhat over-excited would serve to allay the pernicious effects of the inherent lag or idle current which goes with induction motors, at the same time raising the E.M.F. at the extremities of the line, reducing the drop in the conductors, and allowing the generators to do more work, inasmuch they would not be required to deliver so large a wattless current.

This synchronous motor is also a good rotary transformer, and lends itself very conveniently for charging storage batteries and electrolytic work, the alternating current entering at collector rings, while direct currents are delivered from the commutator brushes. For laboratory work and as a piece of apparatus in colleges that teach electric engineering it is invaluable, for, besides the previously mentioned uses, it may be driven by direct currents as a series motor; further, it may be run at a constant speed as a direct-current shunt motor, while from the collector rings alternating currents may be taken at any frequency, dependent upon the speed, which can be regulated by resistance in the field or armature circuits; or, belt driven, it may be used as a self-inciting alternator.

DISCUSSION.*

Mr. Wagner: Mr. President, I should like to ask Mr. Leonard the effect of switching at the central station on the operation of the motor when running at full load. I have had such motors in operation myself, covering a period of three years, and I find that it is an almost insurmountable objection to the use of the synchronous motor, as the frequent switching found necessary to properly divide the load on alternating-current generators causes the motors to fall out of step. I should like to know if he has covered that point.

Mr. Leonard: What Mr. Wagner says is quite true. If a motor fully loaded has the current switched off, it will slow down to a point so much below synchronism that it is impossible to go on unless the switch be reversed so as to put it in the position of starting. In most stations where these motors have been used the circuits on which the motors are run are not switched, except at hours when the motors are not in service, or it is done while the machines are in multiple, preventing the breaking of the circuit and the cutting off of the current.

Mr. Van Trump: Mr. President, I should like to ask Mr. Leonard if there is not a difficulty in operating those motors due to a difference in the curve—that is, in the wave-line of the motor differing from the generator. I have operated synchronous motors to some extent, and I find there is considerable difficulty in getting any motor to work in this way, due to the difference in the character of the curve of the generator making a fluctuation.

Mr. Leonard: These motors, Mr. President, are wound, as stated in the paper, with a concentrated winding—that is, what is known as the iron-clad winding in alternating-circuit phraseology, and while they operate with a greater torque, that is the ultimate point at which they will fall out of step. The utmost load they will carry with an iron-clad armature is about 15 per cent.—10 to 15 per cent. greater with an iron-clad motor than with a smooth bore winding. Most of the single-phase alternators in general use now, however, are wound with the iron-clad winding, and the only difference that would occur would be that the maximum taut, the limit of the load, would be a little lower with a smooth bore winding than with an iron-clad. The wave-line makes no difference.

Mr. Ferguson: Mr. President, I should like to ask the gentleman a question. I wish to know if there is not a danger, in case that machine was started up on a light load, and the operator did not fix the switch in time, of allowing the machine to accelerate its speed to such an extent that it would go all to pieces.

Mr. Leonard: That would happen if it were allowed to be carried on to a sufficient extent. The instructions going with the motor state that the switch should be reversed the moment the lamp on top of the switch, directly in front of the man whose hand is on the handle—just the moment he sees that light his instructions are to reverse the switch. If he fail to do that, and there is no load on, the acceleration of speed might go on, as Mr. Ferguson suggests, to an extent sufficient to throw the armature windings out and injure them. We have had very few cases of that, however. The thing has occurred, and it might occur with a careless hand; but if a man does it once, he never does it again.

Mr. Wagner: Mr. President, I should like to refer again for a moment to the question of central-station switching. It is found necessary to divide the load between a great number of generators at certain times of the year, quite early in the afternoon, long before the motor load is taken off; in other words, at a time of the year when the day and night loads overlap, and it seems hardly possible to delay such switches to such times of the day—say, after six o'clock—when the motors are generally not in operation. Mr. Leonard admits that the motor must stop if any such switching occurs at the station. His reference to stations where generators run in multiple applies to plants which are very recently installed or in process of installation. Until the last few months, I might say, there has been practically no place in the country where stations were operated in multiple. We are anxious for a motor that will operate on existing stations and under existing methods, and it seems to me he fails to brings that point out very clearly—how such stoppages of the motor service are to be prevented.

Mr. Leonard: In practice, we have not had very much objection on account of the feature mentioned by Mr. Wagner. Of course, if circuits are switched when the motor is loaded, and the phases are not exactly coincident in both generators, which is hardly likely to be the case, the motor will fall out of step, but it seems to me that it might readily be arranged so that feeders supplying the motor power could be handled in such a manner that it would be unnecessary to switch very much during the hours of the motor load. In the little experience that we have had we have found no great objection upon that point. In some cases it has been necessary to switch—for instance, at thunder shower, or something of the kind coming up, and darkening everything suddenly, then it has been necessary to switch. But the attendants at the central station generally know which circuits these motors are on, and they endeavour in most cases to avoid switching the motor circuit. It is an easy matter, however, in case the motor is thrown out of step, by cutting off the current for a few seconds, to start the motor again, and it is a matter that takes only a few seconds, and as there is a great demand for these motors, people are willing to put up with that slight objection, or adjust their conditions so as to avoid this difficulty. At least, that is what we have found.

Mr. Wagner: I wish to say, Mr. President, that I do not make these criticisms as reflecting at all upon Mr. Leonard's motor, but merely from the fact that I have had motors of exactly the same type in operation for the last three years, and have finally decided that I would have to give up work in that line, as such objections seem to be insurmountable in ordinary practice. I admit that I failed to solve the problem myself.

* The *Electrical Review* (New York).

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THE WENSTROM ALTERNATE-CURRENT MOTOR.

The inventor of this type of alternate-current non-synchronous motor was an early worker in the field of motor design, and his patent will be found to be exceptionally clear and lucid. The results of his research and practical experience in the matter are now laid before the English public, as Messrs. Fuller and Co. have taken up the sole agency for the supply of these motors. As referred to above, these motors are of the non-synchronous type, with squirrel-cage armatures, as shown in Fig. 1. The armature,

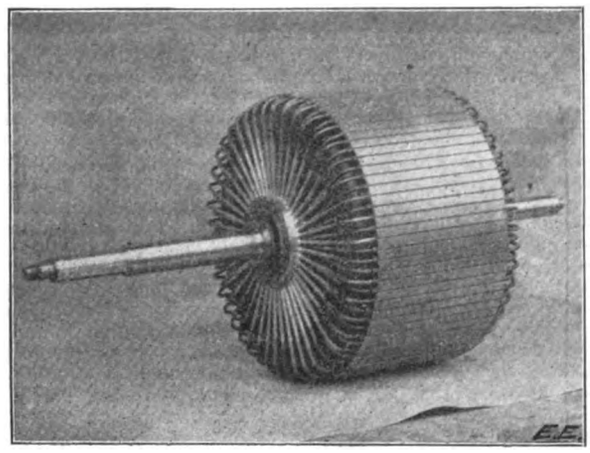

FIG. 1.—Armature of the Wenstrom Motor.

or, as some writers prefer to call it, the rotor core, is made in a similar manner to that of a direct-current drum armature. The conductors are threaded through holes in the periphery, and are then all connected together at the ends by being sweated into gunmetal rings on the shaft. The inductor is similar in design to others described before in our columns. The diagrams of connections when starting and in full work are shown in Fig. 2. The difference of

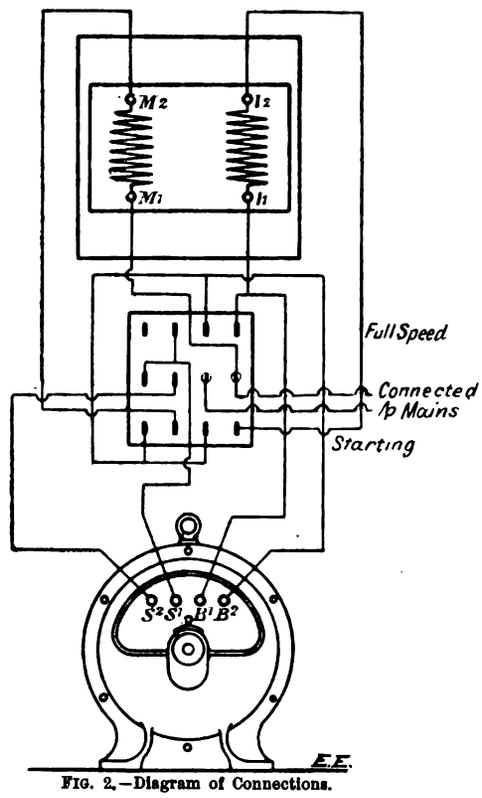

FIG. 2.—Diagram of Connections.

phase required to start the motor is produced by the use of differentially-wound choking coils. When the motor has attained a considerable speed, the switch is thrown over and the one circuit in the inductor is connected direct to the main, while the other is short-circuited. The trouble with such motors lies in the fact that they will not start under load. This difficulty has been most ingeniously overcome in the present case by an automatic clutch gear in the pulley (Fig. 3). The pulley, A, is not keyed to the shaft, but is free to revolve independently of it. The inside rim of the pulley is lined with leather, B. A boss, C, having a number of radial spokes, E E, is keyed to the shaft, and on these spokes a number of weights, D D, are carried. When the motor is at rest these weights are kept in close to the shaft by compressed spiral springs, which can be seen in the figure. As soon as the motor gains speed the centrifugal force causes these weights to fly out and to press against the leather rim. The whole pulley is thus driven, and at the normal speed the driving is absolutely without slip. The following test of one of these motors was recently made at the manufacturer's works in Sweden, and will be of interest to our readers. The speed of the motor, which was rated at ½ h.p., was 3,000 at a frequency of 100. This fell to 2,800 revolutions at full load. The

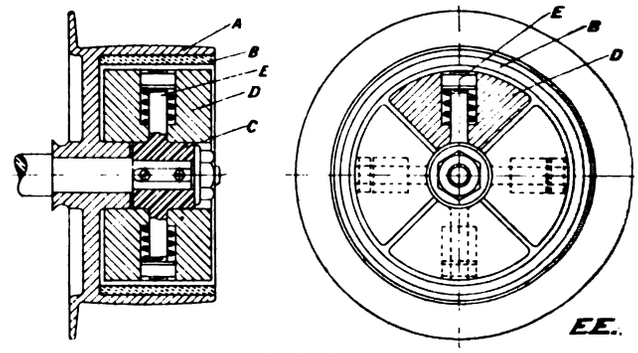

FIG. 3.—Details of the Patent Clutch Pulley used with the Wenstrom Motor.

current taken was 6·5 amperes at 100 volts, and as the power factor was found to be be 85 per cent., the commercial efficiency works out at 68 per cent. This is good for such a small output.

These motors may be seen at work at 28, Bush-lane, Cannon-street, and we are informed by Messrs. Fuller and Co. that the prices will compare favourably with those of other alternate-current motors in the market.

PROF. EWING ON HYSTERESIS.

The Friday night lecture at the Royal Institution last week was delivered by Prof. J. A. Ewing, and was on the subject of hysteresis.

PROF. EWING began with the remark that he believed it was just possible that there might be one or two among his audience who did not know what the subject of his lecture really was. He had been credibly informed that the hall porter had been consulted on the matter, and that a lady had expressed the hope that it was something about hysterics and hypnotism and the whisperings of the angel Gabriel. He much regretted that he had no information to give them in that direction. Moreover, in the *Academy* he had found the subject of his lecture referred to in the "Science Notes" as "a term of art of engineering, we presume, but which is not to be found in Ogilvy's 'Imperial Dictionary.'" On the other hand, in a technical journal of the same week, he had noticed that Prof. Kennedy had said that there was hysteresis in everything. Now, which of the two was right, the writer in the *Academy* who could not find hysteresis anywhere — not even in Ogilvy's "Imperial Dictionary"—or Prof. Kennedy, who found it everywhere? He thought the truth lay with Prof. Kennedy. According to the papers, there had just been an all-night sitting of the House of Commons and an all-day standing of the Great Wheel. That showed that those two institutions did not work without a certain amount of internal friction; and it was his purpose to show that night that it was in the development of a kind of internal friction that hysteresis consists. Some years ago, in the course of a series of experiments on elasticity, it was borne in upon him that there were a large number of different phenomena which presented the common feature of being really due to a "tendency to the persistence of previous conditions." It was to this tendency, this inherent conservatism of materials, that the name had been given of hysteresis—a word whose derivation was occasionally the subject of mistake, but which, he might say, was formed in a perfectly regular and legitimate manner from a Greek verb signifying to "lag behind," because owing to that conservatism the result did not keep up with the cause of it. One of the earliest examples of this, which was

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actually the subject of experiment, was that if a magnetised iron wire was put under a stress—in fact, pulled—and then relaxed, and pulled and relaxed again, and so on, the magnetism changed by a definite amount with the pull, and returned to its old value when the stress was removed, but the intermediate values were not the same as the pull was put on and taken off, so that if the half-way values of strain were taken it would be found that they did not give half-way values of change of magnetism. [This was shown experimentally.] But it was not a hysteresis of this kind, or that which they found to occur in other physical properties, that he was to speak of that night, but it was the hysteresis to which the name was specially applied—namely, that which occurred in the magnetising and demagnetising of iron by means of the electric current, or, rather, as was the more general case, not only demagnetising it, but reversing the direction of magnetism. The "lozenge" hysteresis diagram was here thrown on the screen, and the lecturer explained that such a closed curve represented the dissipation of a certain amount of energy. That was a matter which had of late attained a high degree of practical importance, because wherever they had the alternate-current system of electric lighting they had the iron cores of the transformers being carried through this cycle of magnetising, demagnetising, magnetising in the reverse direction, and demagnetising again something like a hundred times a second night and day. He had stated before that in the course of this cycle hysteresis caused a dissipation of energy, which took the form of heat wasted in heating the cores of the transformers. It had thus resulted that though when it was first invented "hysteresis" was a term of pure physics, it had now become a term of engineering. With the aid of diagrams on the screen, Prof. Ewing then explained the principle of the magnetic curve tracer which he had on the table. A stretched wire carrying a current was attracted by the specimen core to be magnetised, and its deflection caused a small amount of revolution about a horizontal axis in a mirror connected to it. By a simple arrangement the mirror was further twisted on an axis at right angles to this by the magnetising current. It resulted from this that the spot of light reflected on the screen from the mirror would describe a curve in which the X ordinates were proportional to the magnetising force, while the Y ordinates were proportional to the magnetisation produced. If the course of the spot were followed on the screen, it gave a hysteresis curve of the characteristic shape. The varying form of the curve was here shown, as the degree of magnetisation was varied, and the lecturer then remarked that the practical importance of a means of measuring hysteresis was due to the large quantity of it that was constantly going on in transformer cores. It was no use to burn coal at the central station in order to produce useless heat in the transformer cores, and, therefore, it was important to get iron for the latter which gave as little hysteresis as possible. To do that they must be able to test their iron for hysteresis. He had before him three specimens, each of which had been sold as "soft iron," but of which each gave a widely different value when tested, and one of which was so bad that from an electrical engineer's point of view it ought not to be called soft iron at all. A diagram of a practical hysteresis tester which was on the table was here thrown on the screen, and it was explained that the principle of the instrument was the rotation of the specimen piece to be tested between the poles of a C-shaped magnet balanced on knife-edges. Under the influence of hysteresis, the magnet was deflected in the direction of the revolution of the test-piece, and from the amount of the deflection the hysteresis could be determined. Though not so conveniently for the purpose of measuring, hysteresis might be inferred from the amount of heating produced in the iron, and this led the lecturer to refer to the electric kettle of Mr. Pyke and Sir David Salomons, a specimen of which was on the table. In this, a quantity of small coils containing "hard" cores were arranged under the bottom of the kettle. If the coils were connected up to an alternating current, the cores became heated under the influence of hysteresis, and the heat was transmitted to the bottom of the kettle, and the water in it was caused to boil—or, at least, he (the lecturer) was told it might be. What would be the cost of obtaining enough hot water for a cup of tea by this method he had no figures to show, but such as it was he believed that to be the only case in which there had ever been any useful application of hysteresis. After one more experiment in which the rolling of a steel ball was shown to be checked by hysteresis, when the ball formed part of a magnetic circuit, the lecturer proceeded to the theory of the subject. Exactly five years ago, when lecturing at the Royal Institution on the subject of magnetism, he had had occasion to point out that the phenomena exhibited in the process of magnetising iron could be accounted for on the supposition that the iron in its intimate structure consisted of a great number of groups of very little magnets, and the process of magnetisation consisted essentially in a rearrangement of these groups, so that the little magnets came to point, not in all directions, but in one direction. The groups of elementary magnets were highly stable, so that any process which broke them up would, in general, involve a dissipation of energy and an amount of hysteresis. Now, there had recently been an interesting confirmation of the theory of the nature of the process of magnetisation. The magnetism of a piece of iron could be reversed in two different ways. One way was to reverse the field, leaving the iron stationary, as was done in a transformer, where the current was constantly being reversed in the coil surrounding a fixed iron core. The other way was to turn the iron round in a stationary field, and it was this kind of reversal of magnetism which took place in the armature of a dynamo. Now, it had been objected against the theory he had mentioned that it would lead to the absurd result that if the field were only strong enough there would be no hysteresis when the magnetism of a piece of iron in it was reversed by the second method because the elementary magnets would be absolutely mastered by the force of the field and held firmly in one direction, so that there could be no regrouping of them, and consequently no hysteresis. That had been considered an impossible result, and a difficulty in the way of the theory. Lately, however, Prof. F. G. Baily had been experimenting on the question, and had found that when rotated in a very strong field iron did not exhibit hysteresis. So that the result, which was so contrary to preconceived ideas that it was considered as an objection to the theory, turned out on examination to be true. In illustration of the theory a model was shown, consisting of a quantity of small magnets free to revolve about their centres. Left to themselves, these magnets arranged themselves under their mutual attractions in such a way that their poles pointed in different directions. If a field of gradually increasing strength were produced by an electric current the original grouping was broken up, the little magnets swinging into the direction required by the field, not all at once, but gradually as the strength increased. Ultimately, when they all pointed in the same direction, there was a condition of things which corresponded to magnetic saturation, when no further magnetisation could be produced by increasing the magnetising force, because all the elementary magnets capable of direction had been directed. It was also shown—though probably from considerations of time the point was not insisted on at any great length—that when the groups broke up to rearrange themselves the process in each group was not a gradual but a sudden or catastrophic one, and therefore produced a dissipation of energy. A modification of the model capable of rotation illustrated Prof. Baily's result. In no field the little magnets revolved as a whole without rearrangement, there being nothing to disturb their natural grouping, while in a strong field they continued always pointing in the same direction, however rapidly they were carried round, so that again there was no rearrangement; but with intermediate strengths they began to revolve as a whole as in the first case, but as soon as the deflection with regard to the field became considerable, the groups begin to break up and rearrange themselves. Prof. Ewing then called attention to a curve diagram in which the results obtained by Prof. Baily were embodied. [In the diagram the ordinates representing the hysteresis obtained by alternating the field increased continuously with an increase of magnetising force, the curve tending apparently towards an asymptote lying at an angle between the X and Y axes, while in the case of rotation, though the ordinates at first increased faster than in the former case, they attained a maximum and the curve turned over, and cutting the first curve came down again towards the axis of X.] Lastly, returning to general considerations, the lecturer threw out the suggestion that it might be possible to explain a number of other phenomena in physics by means of conceptions similar to those above. For instance, when one body rubbed against another they had the well-known effects of mechanical friction. Those might really be the consequence of the breaking up of stable groups of molecules in the rubbing surfaces under the influence of some species of polarity—conceivably, for instance, of electrostatic polarisation. In conclusion, if some of his hearers had found themselves engaged in digesting the meaning of one sentence while he (the lecturer) was already well on his way through the next one, he hoped that they would look upon it in the light of a necessary hysteresis result, because the time limit imposed on a Royal Institution lecture was all too short a one in the view of the lecturer.

INSTITUTION OF ELECTRICAL ENGINEERS, May 28.

At last night's meeting the following candidates were balloted for:

Members.—**A. B. Larkins, Indian Government Telegraphs; Richard Threlfall, Hollowforth, Lancashire, England, and Sydney, New South Wales.**

Associates.—**John Henry Alexander, Dundonald, by Kilmarnock, Scotland; Gordon Bryant, 32, Camperdown, Great Yarmouth; Henry Conner, Electric Lighting Station, Shrewsbury; Alfred T. Cummins, Electric Lighting Station, Belfast; Herbert H. B. Deane, care of Messrs. Verity and Son, 31, King-street, W.C.; Hugh Hellman, 62 and 63, Central-buildings, Johannesburg, S.A.R.; George Arthur Morton, 22, Ridley-villas, Newcastle-on-Tyne; Hubert Russell, 31, King-street, W.C.; Thomas H. M. Swinburne, Woodlands Park, Altrincham.**

Students.—**Trevor Duesbury, 106, Rose Hill-street, Derby; Herbert Durtnall, Cannon-street Hotel, E.C; Theodore Arnold Locke, Walton-grove, Chesterfield; Robert A. D. Macalister, Faraday House, Charing Cross-road, W.C.; Hubert Sadler, Cannon-street Hotel, E.C.**

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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WILLANS AND ROBINSON.

We believe it was Froude, in one of his essays, who pointed out the great difficulty in obtaining accurate history. It would be interesting if some Mahatma or equally learned person would describe to us of the nineteenth century the struggles of the historian of the twenty-fifth century to find out what was correct and what was incorrect about this year of grace 1896. Surely, one of our descendants, in the attempt to reconcile, say, the statements of the *Chronicle* with those of the *Standard*, would fail, and if the trouble in getting at the truth of political and social questions is Herculean, what about the trouble in getting at the truth about scientific questions? So far as we are concerned, we do not hesitate to say that the firm which has played most part in the development of the high-speed direct-driving engine for electrical work is that of Willans and Robinson. Whatever may be the claims of other builders—and they are many and important—we must contend that in the early days of the era of electric lighting Mr. Massey, Mr. Crompton, and Mr. Willans conferred ofttimes about the adaptation of the then Willans engine to electric lighting purposes. We are writing from memory, but if our recollection of the then state of affairs is correct, it was Mr. Massey who took the initiative in the matter in that he foresaw the necessity of such an engine, and, knowing Mr. Willans and his engine, thought that it might be adapted to the purpose in view. The ardour with which the late Mr. Willans threw his great talents into the solution is known to the world. His papers show the grasp he had of the whole subject, and since his untoward death Mr. Robinson has continued in the path marked out by the then partners, to the immense benefit of the electrical industry. These are facts which, we think, can hardly be disputed. At that early period there existed at Thames Ditton a small works owned by men of superior intelligence. The rise of electrical work was their opportunity, and they eagerly and successfully seized that opportunity to move along the road which led to fortune. Success meant larger works and increased capital. These were obtained; but the tide still flows, and the works at Thames Ditton have proved in the larger sphere of operations to be somewhat misplaced. Business men connected with big works know full well that geographically a works may be unsuitably placed. The position that answered very well under one set of circumstances does not answer so well under other circumstances. Thames Ditton might do admirably as a centre to build launch engines, but not for the larger work of electric light engines. The increase of the capital of a company is seldom of sufficient importance to deal with as we are now doing, but we feel that exceptional features are here before the public. The firm and the existing company have developed a business which is somewhat phenomenal in character. They are shifting their works, increasing their plant, and asking for further capital in view of the increasing demands. There is no doubt, so far as science and practice can see at the present moment, but that electric lighting

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and electric power distribution will continuously increase, even in a greater ratio than the increase of the past ten years. So long as land is valuable and space is thereby restricted, the class of engine developed by Willans and Robinson must be largely used; and these makers, who have done so much up to the present, will surely not allow competitors to take their places in the race, but will hold their own increasingly. Assuming, then, that the energy and talent now shown in carrying on the works will continue, there seems no safer investment in the market than the one offered. Indeed, we should not be surprised to learn that the issue was covered many times over.

IS IT POSSIBLE?

A letter in the *Times* of Thursday describes some high-handed proceedings of the National Telephone Company—at least, they would be described as such if the facts are correct as stated. The sentences which describe the proceedings are as follows: "Sir,—My experience with regard to the proceedings of this company is similar to that related by your correspondent Mr. Barham in the *Times* of Saturday. Some months ago I found their men setting up poles near my property here, and one who acted as foreman told me that they were going along the main road, which passes through it, by the authority of the county council. I forbade them to enter on my land unless the company first gave me an undertaking, countersigned by the county council, similar to that volunteered by the Postmaster-General when the telegraph line was made. Without any such undertaking they set up their poles for a mile along the road, obstructing the footpath itself where there was no margin by its side."

The company, we are told, caved in upon the gentle remonstrance of a lawyer, put their poles where they were permitted to go, and pay a way-leave. The queer part of the story is to be found in the following sentence: "Their policy—shrewd, if not honest—is to count on the supineness of landowners—who, I believe, lose their rights if not asserted within six years—and on their ignorance, in many cases, that the centre of the road, not the side, is the boundary of the adjacent fields." Landowners ought not to be ignorant of the law upon any matter which affects their property; but if they are, it should not be possible under any circumstances for a trespasser to become a permanent resident after once his trespass has been ascertained.

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

June 2, 8 p.m.—At Great George-street, Westminster, S.W. Annual general meeting (corporate members only).

Institution of Electrical Engineers.

May 29, 4 p.m.—At 28, Victoria-street, S.W. Business meeting (members only).

Institution of Junior Engineers.

May 30, 10.30 a.m.—Visit to the Fowler-Waring Cables Works, North Woolwich.

Liverpool Engineering Society.

May 30.—Visit to the Chorley Reservoir.

CITY AND GUILDS OF LONDON INSTITUTE TECHNOLOGICAL EXAMINATIONS, 1896.

ELECTRIC LIGHTING AND POWER.

ORDINARY GRADE.

Instructions.

The candidate must confine himself to one grade only, the ordinary or honours, and must state at the top of his paper of answers which grade he has selected. He must not answer questions in more than one grade.

If he has already passed in this subject in the first class of the ordinary grade, he must select his questions from those of the honours grade.

Candidates for honours must have previously passed in the ordinary grade. They may select their questions from Section I., electrical instruments; or Section II., dynamos, etc.; Section III., electric light and power; but they may not answer questions in more than one section.

The number of the question must be placed before the answer in the worked paper. Not more than 10 questions to be attempted in either grade.

1. What is a choking coil? Why will it not choke a steady continuous current?

2. Define one watt, one kilowatt, and one horse-power. Also, if 1ft. = 30·48cm., and 1lb. = 453·6 grammes, calculate the number of ergs equal to one foot-pound at a place where the acceleration of gravity is 981cm. per second. Lastly, calculate the number of ergs per second equal to 1 h.p.

3. Explain what is meant by the statement that in an inductive circuit an alternate current is out of phase or step with the E.M.F.

4. Why are alternators so commonly separately excited? How can they be made to be self-exciting?

5. What is the difference (*a*) in connections, (*b*) in construction, between a shunt-wound and a series-wound dynamo? Why are arc lighting machines not generally shunt wound?

6. Why is it dangerous to lift the brushes of a shunt-wound dynamo when shutting down? State what would occur if you were to lift the brushes of a running shunt-wound dynamo (*a*) while a fair load of lamps are being supplied; (*b*) when no current is being supplied to the external circuit.

7. Calculate the number of (alternating) volts needed to drive an alternating current of 10 (virtual) amperes through a choking coil having a coefficient of self-induction of $\frac{1}{100}$ henry, the frequency being taken at 80 periods per second.

8. Is the flesh side or the hair side of a leather belt run against the pulley of a dynamo? Give reasons. Also state what advantages there are in rope driving over belt driving.

9. Give a sketch, or sketches, to illustrate the winding of a drum armature for use in a four-pole field.

10. State how much is (approximately) the rated power of motors used in electrical tramcars. Also state on what it is, in an electric motor, that the torque or turning moment depends.

11. How would you test the number of watts per candle required by any glow lamp? How much would you expect these to be in lamps whose average life is 1,000 hours?

12. Describe briefly any kind of supply meter with which you are familiar. What types of meter are most likely to register with small loads? Give reasons.

13. Make a full-size hand-sketch of a quick-break switch.

14. It is required to charge 55 accumulators (ordinary sort, with lead, etc., plates) whose ordinary rate of discharge is 100 amperes. There are available four dynamos of following sorts: (*a*) a series dynamo, 50 amperes at 130 volts; (*b*) a series dynamo, 100 amperes at 50 volts; (*c*) a shunt dynamo, 50 amperes at 130 volts; (*d*) a shunt dynamo, 100 amperes at 50 volts. Which one would you employ, and why?

15. It is found that a motor (shunt-wound, separately excited, or series-wound) that is supplied from mains at

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constant pressure runs faster if its field magnet is weakened. Explain (1) the reason for this fact; (2) what arrangements you would make to weaken the field magnet in the case of each of the three sorts of motors mentioned.

16. Point out in what way the pressure at the secondary terminals of a good transformer depends on that at the primary terminals and on the respective number of windings and their resistance. A transformer with a well-closed magnetic circuit is taking 10 amperes at 2,050 volts. Its primary coil consists of 860 turns of wire having a total resistance of five ohms. Its secondary consists of 43 turns, with a resistance of $\frac{1}{80}$ of an ohm. Assuming that magnetic leakage, eddy currents, and hysteresis are negligibly small, calculate the pressure at the secondary terminals when 200 amperes are being supplied to the lamps.

17. What is the rule for calculating the "intensity" of the magnetic field in the middle of a long tubular solenoid? If the winding is uniform all along, what is the intensity of the field at the open ends as compared with that in the middle? Where must an iron bullet be placed so that the force exerted on it by the solenoid shall be a maximum?

18. What is the three-wire system of distribution, and why is it used? If any one of the three wires is to be earthed, which one would you select, and how would you "earth" it.

19. Give a sketch, roughly to scale, showing parts full size, of a d'Arsonval galvanometer, and describe particularly how the current flows through it.

20. Briefly describe the Clark standard cell.

Honours Grade.

Candidates in honours must have previously passed in the ordinary grade. They may select their questions from one only of the following sections.

Section I.—Electrical Instruments, etc.

Answer questions Nos. 2, 7, and 19 of the ordinary grade, together with not more than *five* of the following:

21. Show the connections for a potentiometer to test E.M.F.'s from 1 up to 1,000 volts, and currents from 1 up to 1,000 amperes.

22. What temperature errors are likely to exist in hot-wire voltmeters?

23. In alternating-current instruments of the solenoid and core type, does any error come in from any of the following causes: (*a*) eddy currents in the core, (*b*) eddy currents in the bobbin, (*c*) hysteresis in the core, (*d*) heating in the core? If there are any errors at all from these causes, which way will they affect the readings?

24. Give a brief description of (1) any kind of alternate-current meter which measures the energy; (2) any kind of continuous-current meter which measures the time-integral of the current. Say what kind of errors might be expected in each.

25. Discuss the principle of the magnetic brake used in so many meters; and point out (1) why it is so much more trustworthy than any other kind of frictional device; (2) what are the necessary conditions that its retarding drag shall be accurately proportional to the speed?

26. What standard of light would you use in a photometer for testing glow lamps. Give reasons for your choice.

27. There are several kinds of photometer of greater sensitiveness than the old Bunsen grease-spot photometer. Describe the arrangements of the one best known to you.

28. Describe a set of apparatus suitable for showing Tesla's high-frequency experiments, the source of supply being the ordinary alternate current at 100 volts. State the sizes of the wires and the special modes of insulation adopted.

Section II.—Dynamos, Motors, Lamps, etc.

Answer questions 7, 9, and 14 of the ordinary grade, together with not more than *five* of the following:

29. Show that in an armature there is no appreciable mechanical force upon the conductors, due to the current in them, if they are embedded in holes in the core discs.

30. What is meant by the "skin effect" in conductors carrying alternating currents? What is it due to? Is the skin effect appreciable (*a*) in a large transformer wound with solid rod as secondary? (*b*) in a large dynamo whose armature has solid copper rods embedded in the iron?

31. Why is the "drop" or want of regulation in a transformer more marked when it is working on an inductive circuit than on a circuit where the load is purely non-inductive?

32. What must be the value of the (alternating) magnetic flux in an iron core if, with a frequency of 100 periods per second, it is to generate 40 volts (alternating) in a coil of 100 turns surrounding it? What cross-section of iron would be suitable to carry this alternating flux or total field?

33. Describe the armature of a motor suitable for a tramcar, giving rough sketches showing the general dimensions and scheme of winding.

34. What are the difficulties in running transformers of different sizes in parallel at various loads?

35. Give an explanation in your own language of how a two-phase ("double-current") or a three-phase ("triple-current") motor works.

36. Discuss briefly the effect, if any, of the form of the wave of an alternating pressure upon the efficiency of transformers.

37. Explain the synchronous running of two alternators on the same circuit. If one of the alternators is running as a motor with a constant load, show under what conditions the current will be a minimum.

38. Why is there any difficulty in running two arc lamps (continuous current) in series on 100-volt mains? What is the inherent property of the arc itself that occasions this difficulty? What are the essentials of success in lamps for this service.

39. Describe one of the special kinds of motor-dynamo used for equalising pressures in a three-wire system of distribution.

40. Give a brief account of one recent method of reducing cross-induction in continuous-current dynamos, or of eliminating the disturbing effect on the brushes of its variation when the load varies.

Section III.—Lighting and Power Supply.

Answer questions 3 and 10 of the ordinary grade; together with not more than *six* of the following:

41. In a central station supplying continuous current on the three-wire system, what arrangements would you adopt to keep the pressure constant at the consumers' lamps?

42. Discuss the defects and advantages of the various systems of laying low-pressure mains for continuous-current supply.

43. What arrangements would you recommend for coupling large direct-driven continuous-current generators in parallel?

44. Give a sketch of a system of steam-pipes from three boilers to feed five engines.

45. Does electrical energy from waterfalls cost nothing? If not, how would you arrive (approximately) at its cost per kilowatt-hour?

46. Describe any surface-collection or "closed-conduit" system of electric traction known to you?

47. Describe the kinds of trouble that have been occasioned to water-pipes and gas-pipes by badly-designed or badly-constructed electric tramway systems. What arrangements must be adopted in a trolley line with return by the rails to ensure that troubles of this kind shall not occur?

48. A power-house for electric lighting is being erected on a clay soil. What special points must be attended to as to foundations, type of engines, boilers, and furnaces, etc., to prevent nuisances arising to neighbouring properties by reason of vibration, etc.?

49. Give a short description of the electrical features of the Niagara generators.

50. Describe, with sketches, the load curves for a summer day and for a winter day of any lighting station with which you are acquainted. Point out how far the use of accumulators is, or might, in the particular case of this station prove to be an economy (*a*) as regards coal bill; (*b*) as regards wages bill; (*c*) as regards total cost of generating.

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THE UTILISATION OF WATER POWER, ESPECIALLY WITH A SMALL FALL, WITH SOME EXAMPLES OF PLANTS FOR THE GENERATION OF ELECTRICAL ENERGY.*

BY ALPH. STEIGER.

The cheap production of electrical energy is generally recognised to be one of the chief aims of modern engineering science. Nature has provided us in water power with one of the best possible agents for realising this object, and I trust that, in bringing the subject of the utilisation of this free gift of Nature before the members of the Institution of Electrical Engineers, I shall be able to convince them that the water powers of this country, if judiciously utilised, are capable of rendering them great service. In my own country—Switzerland—the electrical engineer is co-operating cordially with the water-power engineer, and electrical installations are rapidly increasing in number. The successful electrical transmission of power to points far distant from its source has been the chief factor in this development. The idea prevails that considerable fall is required to obtain water power, but it is my desire to show and to prove in the following remarks that excellent results are obtainable also with a very low fall—a fall of even less than 3ft. Small falls are more frequently met with in this country than high falls, and will, therefore, have more particular attention in this paper than the high falls found in mountainous districts. The description of a few turbine plants under low falls, some of which are applied to the generation of electrical energy, will be of special interest.

During a long experience in constructing turbines and designing complete plants, I have found that the most difficult were always those connected with the utilisation of a low fall. These difficulties consist chiefly in the variation within very wide limits of both the quantity of water and the fall, while a constant power, and in most cases a constant speed, is of great importance. Generally speaking, the real agent in water power is gravity, and the water is simply the medium to transmit the action of gravity on to the motor which converts it into mechanical work. The action of gravity can take either the form of dead-weight, or of pressure, or of velocity, sometimes called kinetic energy. A very high efficiency is obtained from motors in which the water acts by dead-weight or by pressure, but the slow speed of the waterwheels and the complicated mechanism of the pressure engines render them unsuitable for the purpose of generating electricity; moreover, motors worked by weight or by pressure are only advantageous when working under a high fall. The kinetic energy is the only form in which the gravity can be applied advantageously to the performance of mechanical work under a small fall. The motors using it in this form are the common undershot wheel, the Poncelet waterwheel, and the turbines. It will be sufficient for the purpose of this paper to give the efficiency of the various types of water motors for any fall, without going into a detailed description of those which are unsuitable for driving dynamos. The efficiency of the motors, with the fall for which they are adapted, is as follows:

Fall. Feet.	Efficiency of waterwheel.	Per cent	Efficiency of turbine.
			Per cent.
1 to 5	Ordinary undershot ...	25 to 30	
	Poncelet	65 to 70	70 to 75
	Sagebien	65 to 75	
5 to 8	Low breast	30 to 50...	75 to 80
8 to 15.....	High breast	60 to 75...	75 to 80
15 to 50 ...	Overshot wheel	65 to 75...	75 to 80
Above 50...	Pressure engine.....	75 to 85...	75 to 80

These figures show the interesting fact that, the smaller the fall is, the greater is the gain in power over the old-fashioned waterwheels. Although the smallest fall which would reasonably be utilised by a turbine is at least 2ft. 6in., I will show by some examples that by a turbine suitably constructed and carefully adapted useful power is still obtained under a fall of only 1ft. or a little over. The great variety of fall, water supply, local conditions, and special requirements, of necessity demands a variety of types of turbines.

Turbines are classified, according to the manner in which the water acts in them, into (*a*) "impulse," or "action," turbines, and (*b*) "reaction" turbines; and according to their construction, into (*a*) parallel-flow turbines, (*b*) radial-flow turbines, (*c*) mixed-flow turbines. There is an essential difference between the "impulse" turbine and the "reaction" turbine, as indicated by the form of vanes illustrated in the diagrams (Fig. 1 and 2).

The "impulse" turbine, as usually constructed, must run clear of the tail water, its buckets being only partially filled with water. It requires a constant fall, with constant level of the water in the head and tail race, but its efficiency is not affected by the greatest variation of the water supply. On account of this quality, it can be built as partial injection turbine, to utilise high falls with a very small water supply.

* Paper read before the Institution of Electrical Engineers, May 28,

If constructed as "partial injection turbine," its diameter can be chosen so as to give just the desired number of revolutions. This is extremely convenient for driving dynamos, which can thus be connected direct with the shaft of the turbine, doing away with intermediate gearing or belt drives. An instance of this kind is the turbine plant now being erected by Messrs. Escher, Wyss, and Co., of Zurich, at the Falls of Foyers, for the British Aluminium Company, Limited. This plant consists of five "impulse" turbines with vertical shaft, with partial injection, each giving 700 b.h.p., working under a fall of 350ft. The dynamos are required to run at 140 revolutions per minute, and to obtain this speed the turbines were given a diameter of a little over 9ft. Partial injection turbines under a high fall are sometimes fixed on a horizontal shaft, and can thus be coupled direct to the armature spindle of a dynamo by means of an isolating coupling. This mode has been adopted, amongst numerous other plants, for the electric lighting installation of Davos, in Switzerland, which consists of three horizontal patent turbines of 200 b.h.p. each, working under a fall

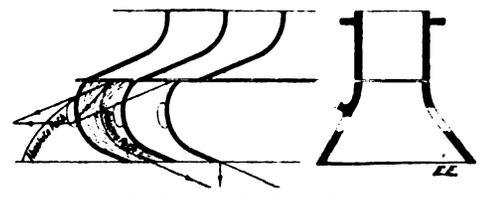

FIG 1.—Vanes of "Action" Turbine.

of 330ft., and running at 400 revolutions per minute. The turbines have a diameter of 40in. As a contrast to these turbines of large power and small diameter, and to show the adaptability of the partial injection turbine to special requirements, the 140-h.p. turbines of the waterworks in Chauxdefonds may be mentioned. These work under a fall of only 170ft., but as they are driving pumps at the low speed of 60 revolutions they had to be made of a diameter of 15ft. Great as the advantages of the "impulse" turbines are under the conditions above mentioned, their use under very low falls is limited, firstly, owing to the reason already given that they must run clear of the tail water—a condition which can seldom be realised in a flat country like this; and, secondly, because they run at a slower speed than a "reaction" turbine under the same fall. Although "impulse" turbines are now built to run in the tail water without considerable loss of efficiency, the reduction of power in proportion to the reduced fall, and the quantity of water accordingly reduced, together with the reduced speed, excludes them in the majority of low and varying falls.

The ideal turbines for low and varying falls are the "reaction" turbines. They are generally placed in a level with the tail water, or, if local conditions require them to be placed above tail water, connected with it by a suction tube. They run at a higher speed for the same fall, or the same diameter, than an "impulse" turbine, and their efficiency is not affected by the immersion in the tail water. The principal objection raised against "reaction" turbines in general

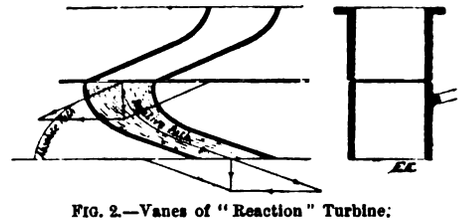

FIG. 2.—Vanes of "Reaction" Turbine.

is that their efficiency is greatly reduced when working at part gate. This is indeed the case with many of the reaction turbines known in this country, which give a very poor efficiency at part gate, especially at less than half gate. The continuity of flow of the water through the buckets is essential to a good efficiency. Only in a few reaction turbines is this condition fulfilled to such an extent that within very wide limits of the water supply the efficiency is not perceptibly reduced. The utilisation of a small and varying fall, with a varying quantity of water, is a very difficult problem for the water-power engineer. The turbine for a given power under a low fall is larger and runs slower than one of the same power under a higher fall; it is therefore heavier and more costly, and requires heavier gearing, entailing a greater loss of power through friction. A high speed is desirable, especially for driving dynamos, but attempts to increase the speed of the turbine by reducing its diameter may easily result in an inferior efficiency. The efficiency should be as high as possible in consideration of the greater cost of a water-power plant with a low fall, but the proportions within which such a fall and the quantity of water varies is mostly so great that it is almost impossible to obtain the highest efficiency when the water supply is diminished—*i.e.*, when a high efficiency is most

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wanted. The maintenance of a constant power with a constant speed under variation of fall and quantity of water in large proportion can, if at all, only be attained by sacrificing some efficiency. The hydraulic losses must be reduced to a minimum by the most careful construction of the turbine in its essential parts, and it is needless to say that no standard size or type of turbine will fulfil all these conditions by simply consuming all the available water. Even the arrangement of the turbine-chamber is of influence on the results, and requires special attention. On a careful judgment of the local conditions depend the economy and the success of a plant. Unsatisfactory results in water-power plants are caused just as much, or oftener, by bad judgment of the local conditions than by the inferiority of the turbine.

In by far the most cases of low falls, incidental to flat countries, an abundance of water corresponds with a reduction of the fall. The power of a turbine calculated for the normal fall would be reduced, for the time, when an abundance of water reduces it, and, as a consequence, water would be wasted, while the power obtained is insufficient. These cases are, unfortunately, of frequent occurrence. On the other hand, if the turbine is constructed to give off the required power under the reduced fall, it must be partially closed for the diminished water supply with the normal fall, whereby the efficiency would be reduced just when it should be highest, if economy is at all the chief object of a turbine plant. The manner in which a high efficiency can be maintained for a diminished water supply is to subdivide the turbine into several compartments, each of which represents a complete turbine. This arrangement has been adopted by Fourneyron for his well-known outward-flow turbine, and in the modern Jonval turbine. The Fourneyron turbine is provided with a cylindrical gate, which is moved vertically, whereby each compartment is opened or closed. This type has been adopted for the large-power plant on the Niagara Falls, but on the European continent they are seldom used. Their efficiency is very good, but, owing to the narrowness of the buckets, they are easily choked. The Jonval turbine is a parallel-flow turbine, and is, for large variations of the fall and quantity of water, subdivided into two or more concentric compartments. A subdivision in this manner renders it possible to maintain not only the power, but also the speed, under a varying fall within very wide limits. The description of a Jonval turbine installation which I supplied for the Brantham Mills, near Manningtree, in Essex,

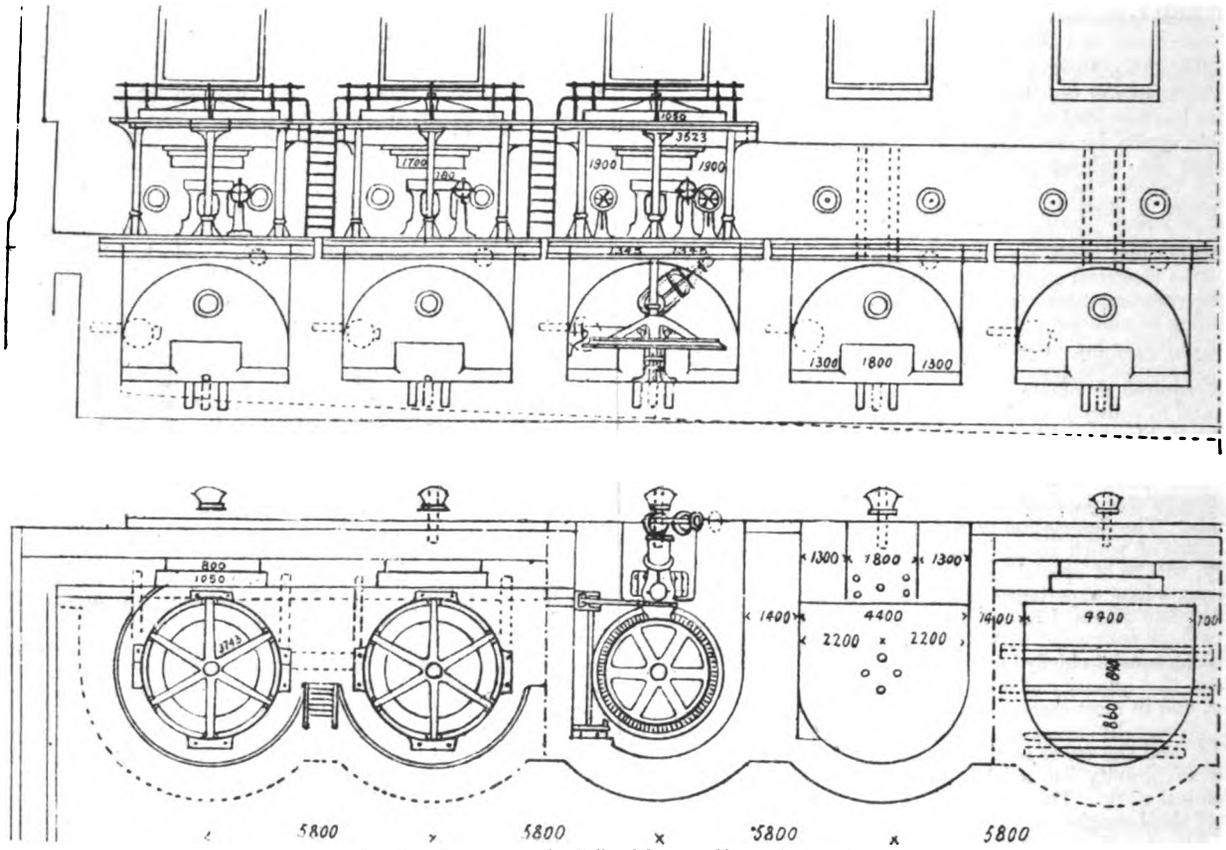

FIG. 3A.—Tu bines at the Falls of Foyers—Plan and Elevation.

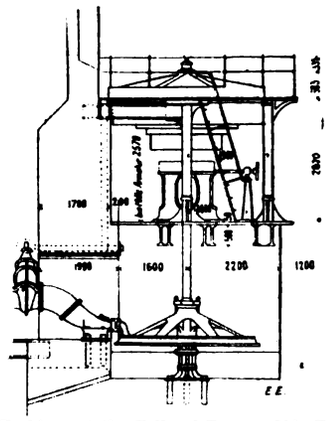

FIG. 3B.—Turbines at the Falls of Foyers—Side Elevation.

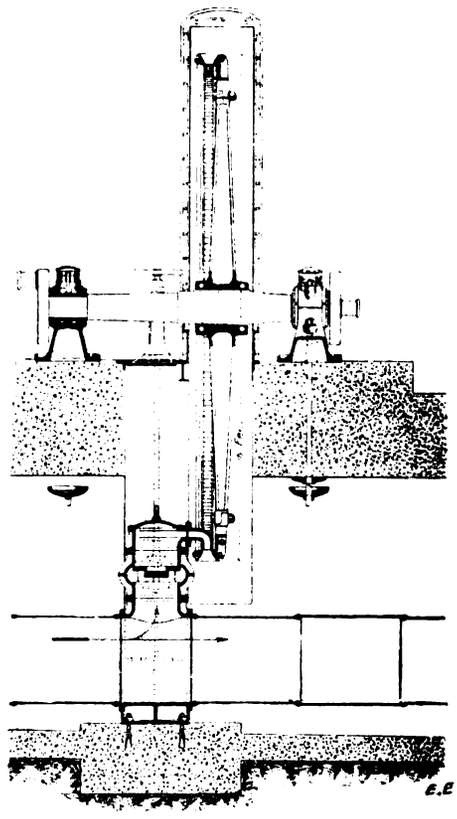

FIG. 4.—Turbines of the Chauxdefonds Waterworks, Switzerland.

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will show that a very small and varying fall can be utilised with great advantage to obtain nearly a constant power. The local conditions and requirements are most remarkable and interesting. The power is used to drive a modern flour mill, in which the maintenance of a regular speed is of equally great importance as for driving an electrical plant. The River Stour is a tidal river, with a maximum fall at ebb tide of 4ft. 10in., while at high tide the fall is nil. The water is supplied partly by the river itself coming down from the hills of Cambridgeshire, and partly by the rising tide filling the river-bed above the mill for a considerable length. The power required is 40 actual horse-power, and it was stipulated that this power should be maintained down to a fall of 40in. On starting the turbine, it was shown, however, that it drove the mill at full capacity and at full speed under a fall reduced to 32in. The full power is available during 16 hours of each day, while during six further hours the power corresponding to a fall reduced down to about 1ft. is still utilised for driving a part of the machinery. Comparing the useful power obtained from this varying fall by the new turbine during 24 hours with that obtained by the undershot water-wheel previously working, it is nearly six times larger. The turbine consists of only two concentric rows of buckets; the inner one is provided with gates, which are opened or closed by hand-wheels, an automatic governor not being generally used in flour mills. The outer row of buckets is just large enough to give the full power required under the maximum fall. As the fall is decreasing by the rising tide the gates of the inner row of buckets are gradually opened to make up the power by an increased quantity of water, and the more water is passing through the buckets of the inner row the more it acts on a reduced mean diameter, thus maintaining also the proper speed without perceptible loss of efficiency. The outside diameter of this turbine is about 10ft., and it runs with 24 revolutions per minute. The power is transmitted from the turbine on to a horizontal main shaft by means of a pair of bevel wheels. This horizontal shaft is made to run at 75 revolutions, and is provided with a clutch, by means of which the turbine is connected with the steam-engine if the mill is required to work continuously. When the fall is reduced to more than 32in. the mill is, however, driven separately by the steam-engine, and the power of the turbine is used to drive the wheat-cleaning machinery, and eventually some pairs of millstones, which can work independent of the automatic roller-mill plant. When the fall is reduced to 15in. the power that is still obtained from this turbine is 7 h.p., the turbine naturally running slower, but still this power is quite sufficient to be profitably utilised.

(To be continued.)

THE NATURE OF CHEMICAL CHANGE AND THE CONDITIONS WHICH DETERMINE IT.*

BY DR. ARMSTRONG, F.R.S.

(Concluded from page 579)

Hence, in studying the manner in which chemical change is brought about, we are necessarily obliged to consider valency, comprehending under this term both the quantity and the quality of the "affinity" possessed by atoms. But, again, progress is trammelled by tradition and fashion—the habit of teaching dogmatically has affected our whole attitude towards such questions, our theories being not only unsatisfactory, but eminently narrow in their disregard of facts, especially apparent in our neglect of molecular compounds. Helmholtz, in his Faraday lecture, after dwelling on the conclusion that definite atomic charges of electricity are associated with the atoms of matter, said that he did not suppose that the existence of other molecular forces, working directly from atom to atom, was to be excluded. But is this the case? I venture to think that, had Helmholtz been a chemist, he would have felt compelled to admit that whatever be the nature of chemical affinity, the same forces are active throughout—that what is termed residual affinity is of the nature of ordinary affinity, and that the difference is in quantity rather than quality. To repeat what I said in 1888 in a note on valency especially as defined by Helmholtz (*Phil. Mag.*, 1888 [5], 25, 21), I do not hesitate to affirm that, from the chemical point of view, it is impossible to adopt the Helmholtz explanation of valency unless physicists are prepared to grant the possibility of the "division" of the unit charge. In the paper in question, to explain my meaning, I developed what may be termed a skewer hypothesis of valency, desiring to give a graphic expression of chemical facts and thus help those who are not chemists to appreciate our position. Representing unit valency or charge by a single line, I postulated this line as capable of passing through the atom, and the atom as moving with more or less of freedom on the line. The union of two atoms was pictured as an overlapping of the unit lines. On this hypothesis, in cases in which the atoms do not move out to the end of their lines on combining, free ends would exist, by the overlapping of which combination between molecules could be brought about; and if it be supposed that hydrogen and the metals alone move freely on their lines in order to give expression to the peculiar differences which apparently are manifest on contrasting the two classes of elements, the combination of a non-metal with a metal may be represented as involving the motion of the former alone out to the end of its line, leaving the line of the non-metal with a free end. In this manner expression may be given to what appears to be a fact—namely, that the non-metals condition the formation of molecular compounds.

What may be termed the *proper valency* of an atom—the number of atomic charges carried by, or of unit lines passing through, the atom—on this hypothesis, is a function of the atom alone, whilst its *residual valency* in a compound is a complex function depending also on the atoms with which it is in association. This is well illustrated in the case of nitrogen by the behaviour of the amines—in all of which the nitrogen clearly functions as a triad—towards haloïds and acids, the extent to which basic characters are manifest depending in an extraordinary degree on the nature of the radicles associated with the nitrogen atom. Assuming that the proper valency of nitrogen is three, the formation of ammonium compounds from amines may be represented as due to the overlapping of the free end of the halogen line and that of one of the nitrogen lines, and if, in a case like that of the chloranilines, it be supposed that the effect of weighting the C_6H_5 radicle by introducing chlorine is to reduce the amount of free end of the nitrogen line to which it is attached, expression is given to the fact that the amine becomes less and less basic, and more particularly that the salt becomes less and less stable as each fresh atom of chlorine is introduced, length of overlap being regarded as the measure of affinity.

It may be asked why, on this hypothesis, if the nitrogen atom carries three atomic charges—is penetrated by three lines—it does not combine with three molecules of acid. Of course, at present no definite answer can be given, but, bearing in mind that the conviction is becoming more and more clearly established that affinity has direction and that geometrical considerations come into play, it is at least conceivable that the direction of two of the lines is such that their free ends perhaps meet, or that they are so directed towards each other that other lines are prevented from overlapping them. The introduction of some such conception would seem to be necessary to explain the remarkable behaviour of compounds such as nitrous oxide and diazoimide, N_3H, the inertness of which is most surprising, whatever view to be taken of their constitution. Certainly, the difference between "unsaturated" nitrogen and "unsaturated" carbon which is manifest on contrasting these compounds with the olefines is most remarkable.

But it cannot be denied that, however possible it may be to "explain" the ammonium compounds on the assumption that nitrogen is but a triad, there are cases in which it is difficult to apply any such hypothesis as the above—one of the most striking being that afforded by the remarkable phenyliodonium compounds described by Hartmann and V. Meyer. It will scarcely be doubted by anyone, I imagine, that these and the equally remarkable iodoso-derivatives are not all to be regarded as proof that iodine is not merely a monad, but also a triad element; and yet it must not be forgotten that an iodine atom can combine with but a single hydrogen atom or methyl group, and that hydrogen and methyl are as yet the only trustworthy and, so to speak, legal standards by which the proper valency of an element can be measured. Even in such a case, therefore, a formula similar to that given to the ammonium compounds—viz., $C_6H_5{\cdot}I{\cdot}I{\cdot}C_6H_5$—cannot be put aside as absolutely out of the question; and if we bear in mind the peculiar character of the oxy-acids derived from the halogens, it is clear that much remains to be learnt of these elements. These acids are often quoted as arguments in favour of the view that the halogens are polyad elements, Mendeléeff having carried his poetic generalisations so far as to claim heptadicity for them; but even assuming that an oxide Cl_2O_7 exists, so long as we are unaware of its structure we must remain unable to judge of the valency of its elements, we are certainly as little justified in assuming that it contains heptad chlorine as we should be in concluding from the existence of a compound of the formula C_6H_6 that carbon is a monad. Valency is far too complex a function to be determined by a simple division method. It is not improbable that the oxy-acids in question are cycloïds.

The solubility of a substance such as triethylphenylammonium iodide in water, in which the amine and haloïd from which it is derived are so slightly soluble—and the fact that in the case of the ammonium salts of the chlorinated anilines above referred to hydrolysis of the salt takes place with increasing facility as the amine becomes less basic—may be referred to in further illustration of the difficulties to be overcome in formulating a consistent and sufficiently comprehensive theory of valency. On the hypothesis that such compounds are formed by the over-

* Presidential address delivered before the Chemical Society.

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lapping of the free ends of the lines of affinity, the compound should remain saturated or externally inactive so long as there was any overlap; on the other hand, if the somewhat more elastic atomic charge hypothesis be adopted, and it be supposed that any portion of the charge remaining unneutralised might be active, at least the case of the chloranilines would meet with an explanation.

But all these are matters of pure speculation, and I should not venture to allude to them did I not feel that it is essential that now the amount of material at our disposal for discussion is so very large it is time that some attempt were made to arrange it in such a form that the results won by chemists can be laid open to inspection by physicists and others capable of taking such transcendental questions into consideration. The theory of types, and its logical outcome, the theory of bonds have contributed in a remarkable manner to the progress of our science; and to these geometrical conceptions have now been added which are leading to further important developments—but it can only be supposed that such theories will all prove eventually to be of provisional value, and that far less mechanical conceptions must prevail.

Underlying all modern chemical enquiries there is an obvious desire to determine the structure of molecules generally, as well as to correlate structure with function; and most important advances in these directions have already been made. Whatever view we may hold, it is only too clear, however, that the conventional treatment of the subject involves the disregard of much that is of the highest importance, especially is it, perhaps, too commonly forgotten that whilst the determination of valency involves the knowledge of the structure of the compounds of elements whose valency is sought, the determination of structure is itself based on an assumed knowledge of valency. We are not only being led to frame the conception that affinity has direction, but also that its strength largely depends on the direction in which it is exercised (as shown by the very different behaviour and stability of cycloïds of different dimensions), and it is more than probable, therefore, that ere long we may formulate a theory in which the somewhat mechanical bonds to which we have become accustomed will give place to a more comprehensive hypothesis.

Faraday, in the paragraph previously quoted, regards both the hydrogen and oxygen in water as possessed of "residual affinity," and in his day, no doubt, there was no reason to draw any marked distinction between the two classes of elements—the metallic and non-metallic. But there is much in the behaviour of the latter which seems to me suggestive of the conclusion that they are the mainly active, attracting elements, and those, in fact, which condition chemical change; I venture to think that this will more generally be admitted to be the case than it is at present when the facts are carefully considered. We have, it is true, long since abandoned the idea that only elements of opposite classes have considerable affinity for each other, but we are not yet advanced much beyond this, and have yet to recognise that the non-metals have very special mutual affinities.

It is in the play of these affinities more particularly that I am inclined to seek that conjoint influence to which I have frequently adverted by which electrolysis, and therefore change is, it seems to me, brought about. The force of the objection made to this explanation, that there are no appreciable reverse E.M.F.'s within an electrolyte, may easily be over-estimated. Adverting to what was said above with reference to the phenomena involved in charging a condenser, if any similar effect were produced in a fluid electrolyte—if any internal polarisation were set up—it would at once be discharged; and such polarisation would be imperceptible, just as in the case of the determination of conductivity by an alternating-current method. A considerable amount of work might, therefore, be done by the current unperceived, and the forces might well be enormous even within the liquid (compare Lodge, "British Association Report," 1890, 330). I am loth to believe also that the low values found for "ionic velocities" are in truth the velocities of the ions, and would prefer to regard them as but differences between values of which at present we have no conception.

A similar argument will apply in the case of osmotic pressure phenomena, and therefore generally in explanation of the regularities observed in the case of dilute solutions. To say that the osmotic pressure is due to the dissolved substance alone, appears to me to be but a useful figure of speech—in reality, the phenomena must be due to both solvent and dissolved substance. Although one attracts the other, however, the unions are probably but temporary, and the opportunities given for exchanges to take place are so infinitely numerous that the dissolved substance behaves practically as an almost perfect gas. From this point of view it is also not remarkable even that the pressure should have the same value as it would have if the substance were gasified, for, inasmuch as the molecules of the dissolved substance are kept apart by those of the solvent, they are practically in the gaseous condition.

As regards the superior effects produced by electrolytes, I would repeat what I said at Leeds in 1890 ("British Association Report"), p. 326, that, having been able by observations of electrical conductivity as well as by other methods to classify electrolytes in the order of their activity, we are now in a position to apply the correction required to discount the superior effects produced by such compounds in comparison with dielectrics. Why they are specially active, the future must decide. To me it seems that their activity is attributable to their special composition and structure—particularly to the presence in them of either oxygen or halogen in an eminently unsaturated condition, and possessed, therefore, of considerable residual affinity.

As regards semi-permeable membranes, as they have been called, I imagine we have yet much to learn in explanation of these. That the membranes through which liquid diffusion takes place cannot be mere sieves, there is hardly a doubt, otherwise it would scarcely happen that gases only diffuse through septa consisting of materials in which they are soluble; as illustrated by the diffusion of oxygen through caoutchouc and silver, of carbonic oxide through iron, and of hydrogen through platinum and palladium.

In the case of colloid membranes, through which so many crystalloïds pass, everything seems to depend on the peculiar relationship of water to such matters—a relationship which is so apparent in many physiological phenomena—and at the same time of water to crystalloïds.

The foregoing may be said to be an essay in advocacy of a theory of *association* in explanation of chemical change, as opposed to one of *dissociation*. The attempt has been made to show that such a theory is of universal application, whilst the dissociation hypothesis is apparently not only of limited application, but in some cases irreconcilable with the facts. It also involves assumptions which it is difficult for the chemist to grant: I allude particularly to the main article of faith in the dissociationists' creed that a certain very limited class of compounds—electrolytes—fall to pieces, as it were, more or less completely on entering into solution. As I have implied over and over again, such an assumption necessitates a profound distinction being made between electrolytes and other compound molecules generally which is not patent to the unprejudiced observer, and for which no motive or reason whatever can be assigned. It must not be forgotten that Clerk Maxwell was led by reasons of this very kind to remark that chemical combination is a process of a higher order of complexity than any purely electrical phenomenon.

I have sought also to make clear the great importance of the part played by "impurity" in Nature in conditioning chemical change—a part which seems to meet with an explanation from the association but not from the opposite point of view. The influence of impurities on properties has also been specially noted.

Lastly, the insight which the study of the electrical behaviour of substances generally promises to throw on almost all of the chief problems of chemistry has been briefly touched on.

I am only too conscious that my discussion of all these questions is not only incomplete, but very general and even vague in many places, language being sometimes used—as in quoting from Faraday—in a sense which may somewhat offend the purist; probably, however, the object I have in view will be clear even in these cases.

PHYSICAL EXPERIMENT IN RELATION TO ENGINEERING.*

BY DR. ALEXANDER BLACKIE WILLIAM KENNEDY, F.R.S., M.I.C.E.

(Concluded from page 577.)

The difference between physical and technical experiments may easily be illustrated by another example from the region of elasticity. The determination of the deflection of a beam, transversely loaded, as a physical experiment, would resolve itself into the test of the behaviour of a piece of homogeneous material, preferably of the simplest possible cross-section, probably rectangular. It would be a matter of importance to ensure that the material was exactly of a certain chemical nature, and that it was mechanically free even from the slightest defects; it would also have to be machined to certain exact dimensions. Even with every care, the almost unavoidable imperfections in the material, minute variations in uniformity of structure, and so on, would be very difficult to deal with and to allow for. As a technical experiment, on the other hand, the beam might consist of plate and angle-irons secured together by rivets, the whole forming a structure with absolutely no pretence to homegeneity, nor to absolute exactness of dimensions. Its rough surface would be carefully left intact, and not in any way machined, its riveted parts would be brought together as well as was reasonably possible with the appliances at the command of the engineer, but without any

* The "James Forrest" lecture delivered before the Institution of Civil Engineers, Session 1895-1896.

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attempt to make a special fit between surfaces. In fact, the whole thing would be constructed in imitation of the way in which a riveted beam, such as is used as a girder, is usually made. The result obtained would obviously not be a general one applicable to steel as a material, or to beams as geometrical forms, because the data of the problem, even the dimensions of the beam itself, could not be determined with minute accuracy, nor would the actual final result be comparable in accuracy with the determination of the similar problem treated from the purely physical point of view. Hence, as the experimenter cannot for a moment pretend, and should not for a moment delude himself into supposing, that his results could be more accurate than his data, it is his first duty in this line of work to find out within what limits of accuracy his experiment can be carried out, and, when he has obtained his results, to state it only within these limits. Under these conditions the statement of a result in round figures is often much more accurate than its statement down to the last decimal place which appears in the arithmetic. I have heard it said by some of the students of the greatest of our physicists, Lord Kelvin, that this was a point upon which, even in a great deal of purely physical work, their master always insisted most strongly. But I am afraid that it must be admitted, as a weakness of much of our engineering experimentation, that its results are given in figures which are absolutely ludicrous as indicating the value of the quantities actually measured. In these matters, perhaps, our friends in America are even worse than we are, and those of us who have anything to do with steam-vessels or with steamship trials are perhaps the worst sinners. I suppose no physical problem could very well be much more complicated than that (I ought rather to say those) involved in the carrying out of a marine-engine trial at sea, especially when power and speed are both concerned. When it is considered that the final result depends on the accuracy of our knowledge of the dimension of the steam-engine itself, and of the steam-engine indicators, on the uniformity of elasticity and proper scale of the indicator springs, the accuracy with which the revolutions are observed, the accuracy of timing on the mile and of observing the distance at the same time, to say nothing of the assumption that the indicators themselves and their gear, unlike every other thing in the universe, are entirely devoid of hysteresis, it will be seen how entirely out of the question it is that the figures obtained, even for a single run in one direction, should admit of statement in, say, more than three figures. When to this is added the uncertainty of the method of averaging speed as between a number of runs under different conditions as to tide and wind, the matter becomes still more striking. Or, when coal and water are also to be measured, and the weighing or measuring of both, and the calibration of all the heavy apparatus used for the purpose, as well as the personal errors due to making observations of large quantities under awkward physical conditions, in a minimum of time and in the worst of atmospheres, are considered, the uselessness and indeed the absolute inaccuracy of extremely minute figures become absolutely glaring. It is sometimes useful, no doubt, under these conditions, to work out results to four significant figures for the sake of mere arithmetical checking; but no one who has had anything to do with the matter would suppose for a moment that more than three figures were of the least importance, and the statement of results of observations in five or six figures merely causes the enemy to scoff. Let me again say here that I am not suggesting, and I do not think, that an experiment of a technical nature is unscientific because its result is only capable of expression within 1 or 2 per cent., instead of within one or two hundredths per cent. I wish only to urge very strongly that in a really scientific spirit such an experiment must be undertaken only with a distinct recognition of its limitations, and of the limitations of accuracy of result such as I have roughly indicated.

But I must claim for technical experiment that it is truly scientific work if only it be conducted with full recognition of its conditions and limitations, and not as if it were a laboratory experiment badly done—a mistake which I fear is too often made. Let it be recognised first of all that our object is generally the determination of certain facts, or quantities, or ratios, which are to be found under certain very complex conditions. As I have elsewhere said, the duty of the engineer is to recognise these conditions and deliberately to include certain of them in his experiment. The physicist has to spend much thought and trouble on the modification of conditions which are disturbing elements in his work. All conditions which might modify his main result, or which might make it difficult for another experimenter to obtain precisely the same value for the quantity looked for, have to be either eliminated or evaluated. The conditions are his enemies, in fact. Otherwise with us, the conditions in general form part of our problem, and for many purposes the reduction of the experiment to its lowest terms, which is the object of the physicist, would not only be impossible, but would, if it could be done, make the result quite useless to us.

The determination of the efficiency of a steam-engine is, of course, a very common piece of work, and may serve as an illustration of the two different ways of approaching such a matter in connection with this question of conditions. From the physical point of view, I imagine it would be best to endeavour to reproduce the working of the much-abused Carnot cycle.* If that were absolutely successful it would merely give us a result which would agree with those which we can already calculate from the physical data which are in our possession, and this result would add nothing to our present knowledge, nor would it give any additional help to the designer of steam-engines.† But it would, if it could be carried out, be an experiment strictly physical, and following in the lines of, for instance, Joule's classical experiment on the mechanical equivalent of heat. The engineer, on the other hand, who has to work at the same problem, has to deal with it in the fashion in which it is now handled in so many engineering laboratories. He has to make himself an actual engine, in which the normal conditions of engine working—as to loss of heat by conduction, condensation, radiation, and so on—are, or can be, reproduced, and he has to make his experiments on this machine, and as nearly as possible under conditions resembling those under which engines normally do work. Then one by one certain of the conditions may be altered, so that some estimation may be made of the effect of each. So may be obtained figures as the result of *bonâ fide* technico-physical experiment, which are also in a form more or less directly applicable to engineering work.

I have just mentioned the variation of conditions one by one. This is hardly a matter which I need insist on. It is of great importance even in a physical experiment, where all the conditions are simplified to the last extent; but in a technical experiment, where the conditions themselves are very complex and often not easy to grasp, it is obviously vital. It is no doubt one of the great difficulties of all technical experiment to find out exactly what the conditions are, and it may in many cases need more experience and more care to determine and define the actual conditions than it does to carry out the measurements involved in the experiment. This is a matter which will be recognised by everyone who has had to do with work of this kind, but about which probably it is unnecessary to say more here. Bearing on it, however, is a matter which may fairly be mentioned—namely, the combining of the results of several technical experiments. This is often very tempting, but is always very difficult. A simple case is, for instance, the determination of the efficiency and of the economy of a steam-engine. A certain experiment may show a certain maximum efficiency; another experiment, on a more or less similar machine, but carried out at another time, may show a maximum economy. Naturally, there is a strong temptation to state both maxima as belonging to the machine tested. It is no doubt possible that they may do so; but on the other hand, without the most minute knowledge of the circumstances of the case, it is quite unsafe to assume that they do, and in this respect the difference between the general character of purely physical work and the special chaarcter of technical experiment comes into clear relief.

In fact, it is much more difficult to handle rightly the results of engineering experiment when they have been determined than those of pure physics. It is by no means always, or obviously, easy to apply these last—at least, one has known very ludicrous mistakes to occur through their misapplication. For instance, I have seen elaborate calculations based on the determination of the weight of steam used by an engine from the pressures shown by an indicator card and the measured dimensions of the engine; and quite recently I was confronted with certain supposed phenomena, which rested entirely on the assumption that a vessel of certain dimensions actually received from a steam-pipe suddenly opened to it only the weight of steam corresponding to its volume and the pressure shown by a gauge! In both cases the troublesome phenomena of condensation were entirely left out of account, and the result of a purely physical determination was applied to a technical problem with very disastrous results. But it is infinitely more difficult often to interpret and to apply the results of our own experiments. For instance, let it be found that one boiler, engine, and dynamo together require the consumption of so many pounds of coal per electrical unit; how much coal per

* I need hardly say that I do not for a moment suggest that any physicist would wish to obtain experimentally a result for which he has already given us all the constants, and which we can, therefore, completely obtain by calculation based on physical results already before us.

† I do not wish here to be understood in the least as sharing that great objection to the Carnot cycle which I know fills the breasts of some of my friends. It appears to me that it would be just as reasonable to object to the asymptote of a hyperbola or to the line at infinity! We require these limiting cases and should get on very badly without them, and I am not inclined to say that they are useless—indeed, I think they are extremely useful—although I am perfectly conscious that they represent a state of affairs which is technically, and even physically, unattainable.

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unit will another boiler, engine, and dynamo require? Put baldly in this form the question sounds ridiculous. But after all, is it any more absurd than our constant endeavour—that is, before the days of the present development of engineering experiment—to arrive at similar comparative conclusions from the doubtless unimpeachable figures of an engineering pocket-book? I am sure there must be many of us who can still recollect how painfully we endeavoured to make the statements of Molesworth furnish us with an answer to our own problems, and how entirely we failed to get things to fit in. I do not suggest that the fault lay with the pocket-book. The fault lay in the endeavour to correlate figures and results which in no way belonged to each other, which represented the result of experiments made under conditions quite unknown to us, but certainly varying from each other, and no less from the conditions (possibly also unknown to us) of the problem we actually were trying to work out. I dare say that many of us who have been hungry and thirsty for facts and figures during most of our lives remember very well the joy with which, at a certain stage, we put down in our note-books any kind of experimental results of which we could hear, or of which we could obtain possession by any means, whether they related to steam-engine trials or to girder tests, or to the discharge over weirs. I do not say to dynamo trials, because there were no dynamos in those days! And I am sure that all of us must have suffered pain and disappointment later on when we found how extremely difficult it was to make any use of the much-valued figures that filled our pages; they would never, somehow or other, seem to tell us just what we wanted—there was always something about them which eluded us, one particular matter of vital importance in the data or in the result of which we had no memorandum. The fact is, that it is always difficult to apply accurately the results of experiments made by others, however carefully made and however accurately described. To realise this, even in reference to purely physical work, one need only see how many pages in the *Philosophical Transactions* are sometimes necessary to describe the methods and precautions involved in a determination which has not one-tenth the complexity of such matters as we are compelled constantly to try to measure.

To anyone who wishes to realise to the full the difficulty of dealing with, or applying the very simplest kind of experimental result, I recommend the maddening task, so often lightly spoken of by those who have not tried it, of calibrating indicator springs, and then trying to apply the results to the correction of the corresponding indicator diagrams.

The fact is that no one can usefully apply physical results who has not himself studied the methods by which these results are obtained, either by the royal road of work in a physical or technical laboratory, or by the hard and up-hill method of self-education in the making of technical experiment, without the advantage of the preliminary training which I have mentioned earlier, and hence the importance of the knowledge of how to make accurate observations, which I have insisted upon as a thing quite apart from the knowledge of the actual figures to be obtained by such observations. It would, perhaps, be cruel to say that no one can usefully apply physical results who had not studied the methods by which they are obtained, were it not that nowadays the possibility of such study is open to everybody. One may therefore state the truth in this matter without the fear of making anyone unhappy. I do not know whether I should be far wrong in suggesting that a certain amount, perhaps a great deal, of the very rapid improvement which has taken place in late years in engineering practice in respect to efficiency in the working of machinery, economy in the production of energy, and economy also in the use of material, has been due, directly or indirectly, or both, to the growth of the habit and knowledge of experiment among the present generation of engineers. No one who is familiar with the progress in such matters as I have this evening dealt with, during the last 20 years, and has noted the extraordinary development which has taken place, can fail to be struck with it. No doubt a considerable part of this development has been due to the better education generally of engineers, and particularly to the great extension of engineering literature, in which undoubtedly the engineering newspapers have played a most honourable and important part. But these general causes in themselves would not, I believe, have been sufficient if it had not been for the contemporaneous development of what I may venture to call experimental training, accompanied by a demand on all hands from inventors, manufacturers, and even from the public, for reasonably exact numerical statements in relation to everything which can be measured, instead of the vague generalities which used to pass muster as critical examination of the advantages and disadvantages of any new proposals.

I hope I need not say here that I quite recognise that an engineer's life is not made of experimentation, and that the work of doing is even higher than that of measuring, at least from our point of view. But in dealing with my subject of to-night I am, of course, bound to take up and emphasise this aspect of engineering work. I hope that it may be considered that I have been able to justify my choice of a subject which at first might appear so limited, but which, in reality, I believe so important as that to which I have addressed myself this evening the relation of physical experiment to engineering.

THE PHYSICAL SOCIETY.

At the ordinary meeting of this society on May 22 Prof. Ayrton (vice-president) in the chair, **Mr. R. Appleyard** read a paper on "**Dielectrics.**" The author has particularly investigated the effect of temperature on the dielectric resistance, and has employed for this purpose condensers insulated with mica and paraffined paper. In order to eliminate some of the effects of surface leakage, Price's guard ring arrangement was made use of in all the experiments. The author finds that the capacity of a paraffin condenser varies irregularly with the temperature, but that to within the accuracy attainable with his instruments (1 per cent.) the capacity of a mica condenser is constant between 33deg. F. and 110deg. F. If the resistance of paraffin at a temperature t is represented by $R_t = R\alpha^t$, the mean value for log. and deduced from all the author's measurements being $\bar{1}\cdot 96344$. Experiments made with a parallel plate condenser, with paraffin as the dielectric, show that when the temperature reaches within about 20deg. of the melting point the resistance rapidly falls. When melting commences there is a rapid drop, but while melting is in progress the resistance remains constant.

Prof. Ayrton said he could bear witness to the extreme value of Mr. Price's device, as it completely did away with the necessity for the extreme care previously required to prevent errors due to surface leakage. He regretted that he had not had an opportunity of comparing the author's numbers with some obtained some years ago by Prof. Perry and himself.

A paper by **Prof. Viriamu Jones** on "**The Magnetic Field due to an Elliptical Current at a Point in the Plane of the Ellipse and Within It,**" was taken as read.

Prof. Silvanus Thompson said that this paper was of interest, not only on account of the application which others might make of the author's method, but also in that the correction when applied to Prof. Jones's results brought the international ohm more nearly into accord with the true ohm.

Mr. J. J. Walker said he considered that the paper was more suited to the Mathematical Society. The integration, which the author reduced to elliptic integrals, might be more easily performed by another method.

Prof. Ayrton said that Prof. Jones's value for the true ohm was now 106·302cm. of mercury.

Mr. Campbell read a paper on "**New Instruments for the Direct Measurement of the Frequency of Alternating or Pulsating Electric Currents.**" The author employs two arrangements, in one of which a steel wire, the tension on which is variable, and the other a steel spring, of variable length, clamped at one end, are acted upon by an electromagnet through which the periodic current is passed. The tension or length, as the case may be, is varied till a maximum resonance is obtained, a small contact-piece being employed to detect when this occurs. The instrument exhibited was capable of measuring the frequency of periodic currents of from 40 to 150 double vibrations per second.

Mr. Watson said he thought that in the case of the steel spring there would be a considerable temperature correction, and he suggested a method by which this might be compensated.

Mr. Blakesley asked if the author had found that the spring became magnetised, and thus gave the octave.

Mr. Carter asked whether elastic fatigue influenced the results, and said that a synchronous motor and a speed indicator could be used to measure the frequency.

Prof. Silvanus Thompson suggested that it might be better to employ a polarised apparatus since to avoid the impression of forced vibrations on the spring it was better, as was done in the case of tuning-forks, to make it massive. It had been found in other cases, such as in Hughes's telegraph, and the telephone, that better results were obtained with polarised apparatus. He (Prof. Thompson) had used a telephone, placed anywhere near a magnet traversed by the periodic current, together with a tuning-fork, which gave beats with the note produced by the telephone, to measure frequencies. The variations in frequency ordinarily met with in practice were much greater than it was generally suspected.

Mr. Blakesley said he considered that the advantage of the author's instrument over a telephone and tuning-fork was that it was continuously variable over a large range.

Mr. Enright asked if the author had been troubled by the spring or wire breaking into overtones. In some experiments in which rather long wires were used, he had been troubled in this way.

Prof. Ayrton said that he did not think that it was possible to get the wire or spring to respond to the octave unless the alternating current contained a component of the frequency of the octave. In fact, he had himself used such a stretched string as a wave analyser. He had used a telephone to prove that the note given by a hissing alternate-current arc corresponded in frequency to that of the current. In the instrument used by Prof. Perry and himself a polarised arrangement was always employed, since the alternating current was passed either through a wire in a constant magnetic field, or through an electromagnet which acted on a wire through which a constant current was passed.

The **Author**, in his reply, said that the instrument responded, though feebly, to the octave, and this response might be made use of to check the accuracy of the scale.

The society then adjourned till June 12.

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LEGAL INTELLIGENCE.

THE BRUSH COMPANY AND THE SHOREDITCH VESTRY.

An action was commenced in the High Court of Chancery on May 21 by the County of London and Brush Provincial Electric Lighting Company, Limited, to restrain the Vestry of St. Leonard, Shoreditch, from laying down electric lines beyond the area within which the Vestry are authorised to supply energy under the Shoreditch Electric Lighting Order, 1892.

It appeared from an affidavit that the Vestry commenced on May 21 to excavate a trench for the purpose of laying down electric lines within the parish of St. Luke, Middlesex, a district for which the County of London Company have a provisional order.

On the application of Lord Robert Cecil (instructed by Mr. Sydney Morse), Mr. Justice Henn Collins gave the Company leave to serve summons and writ for June 2, and granted an injunction in the meantime.

COMPANIES' MEETINGS AND REPORTS.

GULCHER (NEW) ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

A meeting of the creditors and contributories of this Company was held on Tuesday at 73, Lombard-street, E.C., to receive the account of the liquidator, Mr. C. Fitch Kemp, in reference to the winding-up of the Company and to consider an offer which has been received by the liquidator from Lloyds' Bank, the second debenture holders having an unsatisfied claim of over £3,000 on the second debenture issue, for the purchase of the outstanding assets of the Company and the closing of the liquidation. Lloyds' offer was to pay £1,300 in cash and discharge the balance of the second debenture debt in return for all the outstanding assets of the Company—that is, a balance of £127 on uncalled capital; a claim (disputed) for £3,000 on the New Zealand Electric Syndicate; and 2,335 £10 shares in that syndicate. The liquidator stated in his report that the cash would be nearly absorbed in discharging a debt of £1,000 and interest, and the balance would be accepted in discharge of the costs of the liquidation, although it would not be sufficient to cover them on any ordinary scale. Failing the acceptance of the offer, it would be impracticable to pay in full the second debentures of the Company unless some substantial recovery were made (which the liquidator considered perfectly hopeless) on account of the debt for uncalled capital due from Miles and Co., Limited, who were in liquidation. While as to the claim on the New Zealand Electrical Syndicate, the assets of that company were situated in New Zealand, and no tangible amount could be recovered, if at all, except at the risk of costly and protracted proceedings in New Zealand, and probably in the English Courts also, the expense of which would have to be provided by the creditors and contributories of the Company. Having regard to his knowledge of the position of the syndicate, the liquidator considered that he would be utterly unjustified in recommending creditors and contributories of this Company to make voluntary contributions for such a purpose.

Mr. Fitch Kemp (the liquidator), who presided, remarked that at present he was under a liability to Lloyds' Bank, and his solicitor and himself were without any costs. He had power to conclude the arrangement indicated above, but as the result was so unsatisfactory, he would prefer not to do so without the sanction of the meeting.

A considerable amount of conversation followed, in which **Major Cotton** and **Mr. Morgan** took part, on the question whether there might not be a possibility of recovering something from the debtors of the Company. Finally, **Major Cotton** suggested that, say, £1,000 (nominal) of the shares in the syndicate should be retained by the liquidator with the view that if at any future time they should become of any value the sum realised might be used in payment of the trade creditors of the Company The case of the shareholders was admitted to be hopeless. It did not, however, appear that Lloyds' Bank would be willing to modify the terms of their offer in this direction, nor did it seem that the whole of the money, if any were ever obtained, would be available for the purpose indicated.

Ultimately, on the motion of **Major Cotton**, seconded by **Mr. Morgan**, the resolution authorising the acceptance of the offer of Lloyd's Bank was carried unanimously.

WEST COAST OF AMERICA TELEGRAPH COMPANY, LIMITED.

The report of this Company for the year ending December 31 states that the gross income as shown in the revenue account was £32 930, as against £21,753 in 1894. The traffic receipts were adversely affected by the stagnation in the nitrate industry and other local causes, but, owing to a readjustment of the proportions of the international traffic receipts for the year, the income was sufficient to pay the expenses and the interest on the debentures. The total expenses were £20,930, against £20 154. The repairing steamer "Retriever" has been fitted with a new steel main boiler, the cost of which (£1,978) has been charged to the reserve fund. The steamer is now considered to be in first-class condition, and, outside of accidents, fit for service for the next 12 years. The cables and land lines are maintained in good working order. The general meeting will take place to-day (Friday).

BOURNEMOUTH AND DISTRICT ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Aymor H. Sanderson, A.I.E E., chairman; J. Atkinson Hosker, M.R.C.S.; R Percy Sellon M.I E E. Consulting engineer: A. J. Lawson, M.I.E.E. Managing engineer: H. M. Sayers, A I E.E Secretary: H B. Renwick.

Report of the directors (with abstract of accounts) to be presented to the shareholders of the Company at the fifth annual general meeting of the Company to be held at the registered offices, Verulam House, Yelverton-road, Bournemouth, on Tuesday, June 2, 1896, at 3.30 p.m :

The capital account shows an expenditure during the year of £20,845. 8s. 7d., chiefly upon buildings, machinery, and mains, the funds for which were obtained by loan from the County of London and Brush Provincial Electric Lighting Company, Limited. The revenue account, notwithstanding a reduction in the maximum price of current from 8d. to 7d. per unit, which was made in the month of April, 1895, shows a total income of £7,431. 3s. 10d., being an increase of £458. 13s. 8d. over that of 1894; and an expenditure of £5,272. 12s. 7d., being a reduction on the previous year's figure of £57. 15s. 10d. The gross profit on the year's working thus amounts to £2,158. 11s. 3d., as against £1,642 1s. 9d. in 1894, but owing to increased charges for interest on sums borrowed for capital expenditure there remains a debit balance of £237. 15s. 9d. to be carried forward. The connections to the Company's mains on December 31 last were equivalent to 20,978 lamps of 8 c.p., the increase for the year being equivalent to 1,798 lamps, or 9½ per cent. upon the number connected on December 31, 1894 The number of Board of Trade units of current sold during the year amounted to 243,816, as against 214,374 in 1894, an increase of nearly 14 per cent., whilst the total cost per unit was reduced from 5·91d. to 5 19d. The generating station has been rebuilt and rearranged during the past financial year, and with the advantage of the many improvements which have been adopted the directors believe that a considerable further reduction in cost of generation during the current year may be anticipated. The retiring director is Mr. J. A. Hosker, who, being eligible, offers himself for re-election. Mr. R. H. Marsh, the auditor, also retires, and offers himself for re election.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1895.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£1,880	1	2			
Oil, waste, water, and engine-room stores	475	6	6			
Proportion of salaries of engineers, superintendents, and officers	316	11	5			
Wages and gratuities at generating station	735	5	6			
Repairs and maintenance, as follows: buildings, £20. 16s. 7d.; engines, boilers, £112. 9s. 11d.; dynamos, exciters, transformers, motors, etc., £96. 11s. 5d.; other machinery, instruments, and tools, £79. 0s. 10d.	308	18	9			
				3,716	3	4
Distribution of Electricity.						
Engineers' salaries	90	1	5			
Wages and gratuities to linesmen, fitters, labourers	93	15	10			
Repairs, maintenance, and renewals of mains	66	7	7			
Repairs, maintenance, and renewals of apparatus on consumers' premises	11	12	10			
Repairs, maintenance, and renewals of apparatus at distributing stations	54	3	11			
				316	1	7
Rents, Rates, and Taxes.						
Rents payable	167	13	2			
Rates and taxes	199	8	8			
				367	1	10
Management Expenses.						
Directors' remuneration	150	0	0			
Salaries of secretary and office staff	238	15	0			
Stationery and printing	93	17	5			
General establishment charges	97	7	9			
Auditor of Company	12	12	0			
Auditor appointed under the provisions of the order	10	10	0			
Carriage	14	15	0			
Advertising	69	10	0			
Stores and works expenses	102	10	4			
Law and parliamentary charges	3	7	0			
Insurances	33	2	6			
Amortisation of leases	10	8	5			
Bad debts written off	36	10	5			
				873	5	10
Profit on year's working, carried to net revenue account				2,158	11	3
				£7,431	3	10

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Cr.	£	s.	d.
Sale of current per meter	6,842	17	7
Rental of meters	383	17	7
	7,226	15	2
Transfer and probate fees, 12s. 6d.; balance of abatements accounts, £25. 7s. 7d.; trading account, £9. 8s 2d.	35	8	3
Rents receivable	117	16	8
Proportion of pupils' premiums	51	3	9
Total	£7,431	3	10

GENERAL BALANCE SHEET, DEC. 31, 1895.

Liabilities.	£	s.	d.
Capital account—amount received	74,858	0	6
Sundry creditors	5,704	18	11
Bills payable	780	14	4
Unclaimed dividends and interest	81	14	9
Manager's house amortisation account ... £40 15 0			
Petunia cottages ditto ... 9 3 5			
	49	18	5
	£81,475	6	11

Assets.	£	s.	d.
Capital account—amount expended for works	71,553	12	3
Stores on hand at December 31, 1895	1,239	12	8
Board of Trade deposit	100	0	0
Sundry debtors	2,807	6	10
Balance of suspense account	3 701	18	10
Special account	398	2	0
Balance of profit and loss account	237	15	9
Cash at bankers, Wilts and Dorset Banking Company, Limited—running account, £1,348. 7s. 4d.; debenture interest account, £59. 13s. 3d.; dividend account, £22. 1s 6d.	1,430	2	1
Cash in hand	6	16	6
	£81,475	6	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units	388 066
Quantity sold to private consumers by meter	243,816
Quantity used on works	7,954
Total quantity accounted for	251,770
Quantity not accounted for	136,296
Total maximum supply demanded—kilowatts	336

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Mako (Hungary).—The municipal authorities of Makö in Hungary are desirous of receiving proposals for the electric lighting of the town.

Prague (Austria).—Tenders are wanted by June 1 for an electric lighting central station for the city of Prague. Application should be made to the Stadtrath, Prague.

London, S.E.—Tenders are required for complete installation of electric lighting. For particulars apply by letter to Mr. H. Freeman, 44, Knatchbull-road, Camberwell, S.E.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years. Tenders should be sent in by August 31.

Santiago de Chile.—The Telegraphic Department of the Chilian Government will receive tenders up to June 6 for the supply of 5,000 glass jars for Leclanché cells and about 3½ tons of sal-ammoniac (pure).

Coblentz.—Tenders are wanted by 30th inst. for the annual supply of 10,000 to 13,000 wooden telegraph poles for four years. Particulars from the offices of the Konigl. Ober-Postdirection, Coblentz for 30pfg. (3d.).

Brussels.—Tenders will be received shortly (the exact date is not yet announced) at the Brussels Bourse for the material and work necessary to start an electric lighting installation at the fifth section of the central locomotive construction works at Malines.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality. Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Dresden.—The Telegraph Department of the Saxon State Railways want tenders by June 10 for about 50 tons of galvanised iron wire (4 millimetres) and 10 tons of smaller sizes; also 3,700 glass jars (various) for battery cells, and 10,000 porcelain insulators large size and 2,000 of smaller sizes as well as 7 500 zincs for Meidinger and 1,000 for Leclanché cells. Particulars from Die Königl. Magazin-Verwaltung, Dresden-Friedrichstadt.

Bucharest.—The Municipal Authorities of Bucharest ask for further tenders up to June 24 for lighting the suburbs and environs "on a system without (underground) pipes more suitable than those that have been already offered." It is desired to replace 3,265 petroleum lamps, and the contract will be for five years. Communications should be sent to the Mairie at Bucharest.

Spandau.—Tenders are wanted at the Royal Small-Arms Factory for 900 incandescent electric lamps by July 17 and for 27,300 sets of arc-lamp carbons by June 12. Particulars are obtainable for 75pfg. (9d.) from Die Königl. Direktion der Gewehrfabrik (Geschäftszimmer No. 21), Spandau.

Grimsby.—Tenders are required by the Urban Sanitary Authority for lighting of the public streets of the borough for one year. Forms of tender, copy of specifications, and any further information may be obtained on application to Mr. Marshall Petrie, borough surveyor, Town Hall. Tenders, sealed and endorsed "Tender for Street Lighting," to be delivered at the Town Clerk's Offices, West St. Mary's-gate, by 5 p.m. on June 5.

Bradford.—The Corporation invite tenders for the works required in the installation of electric lighting at Cliffe-road destructor works. Specification, with form of tender, may be obtained on application to Mr. W. T. McGowen, town clerk, Town Hall, Bradford. Sealed tenders, endorsed "Tender, Electric Lighting at Cliffe-road Destructor Works," to be delivered at the Town Clerk's Office by June 2. An assurance will be given by each contractor that he pays to the workmen employed by him not less than the minimum standard rate of wages.

York.—The North-Eastern Railway Company require tenders for the following articles during six months ended December 31, delivered carriage paid at the telegraph stores at York: (1) telegraph apparatus; (2) telegraph wires and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash less 2½ per cent. discount. Forms of tender may be obtained on application to Mr. Greaves, Telegraph Department, York, and tenders must be sent to the Secretary, York, sealed, and marked "Tender for Telegraph Stores," by noon on June 8.

Croydon.—The Corporation require tenders for the erection of a chimney shaft for the electric lighting station now being built in Factory-lane, Croydon, in accordance with drawings prepared by Prof. Kennedy, Old Queen-street, Westminster. The drawings and specification can be seen at the Borough Engineer's Office, 8, Katharine-street, Croydon, where also bills of quantities and form of tender can be obtained on payment of a deposit of £2. 2s., which will be returned to every person sending in a bona fide tender. Tenders to be sent to Mr. E. Mawdesley, town clerk, Municipal Offices, 8, Park-street, Croydon, by 11 a.m. on June 8.

Glasgow.—Tenders are invited by the Caledonian Railway Company for the supply of telegraph and electric appliances, etc., for 12 months from August 1, 1896. Specifications and forms of tender and any other necessary information may be obtained on and after June 1 from Mr. Jas. Lorimer, superintendent of stores, Caledonian Railway, Charles-street, St. Rollox, Glasgow. Patterns may be inspected on and after June 1 from 9 a.m. till 5 p.m. at the Company's Stores, Charles-street, St. Rollox (Saturdays 9 a.m. till 1 p.m.). Tenders, endorsed "Tender for Stores," to be lodged with Mr. J. Blackburn, secretary, 302, Buchanan-street, Glasgow, by June 15.

Leeds.—The City Council invite tenders for an electrical installation sufficient for the working by the overhead system of haulage, a double track of tramway seven miles long. The work will be divided into the following contracts: (1) poles for supporting trolley wire; (2) underground conduits and conductors; (3) trolley wire and attachments; (4) motorcars; (5) accumulators and switches; (6) steam-engines; (7) dynamos, switchboards, and accessories. Tenders, endorsed with the number of the contract, must be sent in, addressed to the Town Clerk, Town Hall, Leeds, by June 20. Particulars, plans, forms of tender may be had (on payment of a deposit of £2. 2s. for each contract, which will be returned on receipt of a bona fide tender) from the City Engineer, Municipal Buildings, Leeds; or from Dr. John Hopkinson, F.R.S., 5, Victoria-street, Westminster, S.W.

RESULTS OF TENDERS.

Castor.—For providing a lightning conductor to the spire of the parish church of Castor, near Peterborough, the tender of Mr. Campbell, Milton-street, Peterborough, was accepted.

Paris.—The contract for the electric lighting of the Hospice de Brevannes (Seine-et-Oise) has been allotted to Messrs. Durand and Guigné, rue de Trevise, Paris, at 6·6 per cent. abatement on the official estimate.

Coventry.—For the supply and erection of the following plant: (Section A) boiler-house plant—boilers and fittings, mechanical stokers and economiser, feed pump, etc; (Section B) engine-house plant—steam-engine, alternator, oil filter, fittings, etc., steam, exhaust, feed, blow-off, sundry pipes, valves, etc., for the Electric Lighting Committee, the tender of Messrs. J. Fowler and Co., Leeds, £4,198, was accepted.

Wakefield.—The Council have accepted the following tenders for the proposed electric lighting works: brick, stone, excavating, slaters', carpenters', joiners', and plasterers' work, Messrs. Holme and King, Cross Hall-street, Liverpool, £7,887. 15s. 6d.; plumbers' work, Mr. Fred Mosley, Wakefield, £190. 18s.; smiths' and iron-founders' work, Mr. C. Bailey, Savile Town, Dewsbury; painting, Messrs. Charles Turner and Sons, Wakefield; glaziers' work, Mr. John Scaife, Warrengate, Wakefield. The fair contracts clauses were adopted in regard to sub-letting, working hours, and rate of wage, etc.

Hackney.—Mr. S. J. Ross has been appointed engineer and electrician at the baths, at a salary of £156 per annum.

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BUSINESS NOTES.

Aberdeen.—The Plans Committee of the Town Council have sanctioned plans of an extension to the electric lighting station.

Lancaster.—At the meeting of the Town Council it was reported that there was a loss of £539 on the electricity works during the year.

Burnham.—We are informed that Messrs. Donnieson and Co. are still endeavouring to get sufficient support to introduce the electric light into the town.

Chester.—The County Council have decided to grant a sum of £3,000 for the purpose of installing the electric light into the existing asylum buildings at Upton.

Electric Safety Lamps.—We understand that Mr. Sydney F. Walker, of the Cardiff Electrical Works, will shortly bring out an electric safety lamp on entirely new lines.

West African Telegraph Company. — The directors have declared a further dividend of 6s. per share, making a total distribution of 4 per cent. for the year 1895

Barrow.—There is a proposal to construct a light railway from Backbarrow, through Finsthwaite, the Sawreys, and Esthwaite to Hawkshead, and electricity is suggested as the motive power.

Dresden.—The Elektricitätswerke Aktiengesellschaft Kummer und Co. has paid an 8 per cent. dividend, and is about to increase its capital account from one million to 2½ million marks (£125,000).

Address.—Mr. G. A. Steinthal has opened an establishment for electrical contracts and supplies at 7, Brazennose-street, Manchester, the management of which has been entrusted to Mr. W. P. Steinthal, B.Sc.

Folkestone.—The Corporation have decided to refer the whole of the correspondence, agreements, etc., on the subject of electric lighting to an expert of good position to advise on all the various points and to report thereon.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending May 24 amounted to £1,178, as compared with £1,135 in the corresponding week of the previous year, being an increase of £43.

Belfast.—At the meeting of the Electric Committee the usual report was presented by the engineer, and he was authorised to attend the annual meeting of the Municipal Electrical Association in London on June 10, 11, and 12.

Aberdeen.—The Streets and Roads Committee have decided to charge the Telephone Company a rent of 10s. per pole per annum, the Corporation, in addition, to be allowed 25 per cent. reduction on all their telephonic connections.

London Extensions.—Rapid progress has been made with the laying of the mains and the erection of the columns in the West-end. In Regent-street several of the lamp columns are already in position in the centre of the roadway.

York.—A meeting of representatives of the various parishes in the city has been held in reference to the proposed electric lighting scheme, and it was decided to call a mass meeting of ratepayers at an early date to consider the question.

Telephone between London and Nice.—The *Petite République* states that two engineers have made arrangements with the French Government for the establishment at an early date of telephonic communication between London and Nice.

Printing Telegraph Recorder Company, Limited. — This Company has been registered, with a capital of £10,100, to carry on the business of manufacturers of type printing and other telegraph recorders, as telegraph engineers, etc.

Removal.—Messrs. Eugen Conrady and Co., electrical and mechanical engineers, have removed from Keighley to London, where they will continue to manufacture their specialities at the new works, 35, Charles-street, Hatton-garden, E.C.

Dublin.—We understand that the public have patronised this line extensively since its opening for regular traffic. Over 50,000 passengers were carried on the first day, and the number carried up to the present has reached the enormous total of 200,000.

Burnley.—The Electric Lighting Sub-Committee have decided to recommend the Council to authorise the laying of electric cables along Church-street and Ormerod-road, and of sufficient capacity to supply 2,000 lights, at an estimated cost of about £1,000.

Lahore.—The Municipal Committee are considering the question of lighting the streets by electricity. The city and station have been surveyed, and it is hoped a company will shortly be formed who will take up the work as soon as the Local Government can secure the necessary legislation.

The Electric Wiring Question.—The paper which was read on this subject by Mr. F. Bathurst at the meeting of the Institution of Electrical Engineers has been reprinted, with the reply to the discussion, by the General Electric Company, Limited, from whom copies can be obtained on application.

Central American International Exhibition.—With regard to this exhibition, which is to be held at Guatemala next year, the British Consul points out that it might be made a means of introducing more British products into the country. There is at present a great demand for electric plant, etc.

Liverpool.—The town clerk having reported to the Finance Committee that the Bill for the purchase by the Corporation of the Liverpool Electric Supply Company's undertaking would receive the Royal assent, arrangements are being made to complete the purchase and transfer on July 1 next.

Coventry.—At the meeting of the City Council the Electric Light Committee tendered a statement for the quarter ending March 31. The electricity supplied during the quarter amounted to 10 642 units, the rental to £284. 1s., and the mileage of the mains is—high tension, 2 miles 77 yards, low tension, 2 miles 332 yards.

Birmingham.—The project for the purchase of the undertaking of the Birmingham Central Tramways by a new company, with enlarged capital, has given rise to some discussion as to whether on the leases of the lines expiring the City Council should not work them itself, as is done by Corporations at Glasgow, Leeds, and Huddersfield.

City and South London Railway.—The returns for the week ended May 24 were £893, compared with £884 for the corresponding period of last year, being an increase of £9. The total receipts for the half-year terminating as above were £19 693, compared with £19,604 in the same period of the preceding year, being an increase of £89.

Direct Electric Generator (Foreign Rights) Syndicate, Limited.—This Company has been registered to carry on the businesses of manufacturers of and dealers in carbon plates, slabs, rings, crucibles, rollers, bars, rods, pipes, or any other articles requisite for electrical or other purposes, also as electrical engineers and electricians, suppliers of electricity, etc.

Carbon (Foreign Patents) Syndicate, Limited.—This Company has been registered to carry on in all or any of their respective branches the businesses of manufacturers of and dealers in carbon plates, slabs, rings, crucibles, rollers, bars, rods, pipes, and other articles for electrical and other purposes, and as electrical engineers and electricians, suppliers of electricity, etc.

Richmond (Surrey).—Councillor Hilditch, J.P., is agitating in favour of working the Kew tramways by electricity, and he writes to the local Press that he has seen plans of three new systems that dispense with the "objectionable overhead wires." He alludes to the Westinghouse Company's system, the Siemens conduit system, and another subterranean trolley system working in an American city.

Douglas.—At the meeting of the Town Council a letter was read from the tramway company stating that if the Council would have Prospect-hill widened in readiness for laying the rails by June 2 the company would probably complete the upper Douglas cable tramway by June 1. The Council decided that while they would expedite the matter they would not undertake to have Prospect-hill ready by June 2.

Chelmsford.—At a special private meeting of the Town Council it was decided that the question of purchasing the town lighting from Messrs. Crompton and Co. for £34,828—the price asked—should stand over for the present. At the meeting of the Guardians the application of Mr. Clark, of East Hanningfield, to be allowed to put down some posts for carrying electric lighting wires was not granted because it was for private lighting.

The Universal Engine.—In consequence of the demand for the Raworth Universal steam-engine, the directors of the Brush Electrical Engineering Company have decided to extend their works at Loughborough. The new tool shop, which will be devoted entirely to the engine trade, is to be 160ft. long by 48ft. wide. Building operations have already commenced, and it is hoped that danger of delay in the execution of orders may be averted.

Bath —The Urban Sanitary Authority have decided to apply to the Local Government Board for power to borrow £45,000 for electric lighting purposes, made up as follows: sum to be paid to the company as by Prof. Kennedy's valuation, and for land, £24 533; expenses incurred in obtaining the provisional order, etc., about £967; additional capital required as estimated by Mr. Hammond, £14,500; for further extension of main, £5,000—total, £45,000.

Bradford.—At a joint meeting of the representatives of the Iron Moulders and United Patternmakers, the question of fair contracts was discussed in connection with the extension of the Corporation electricity works. Evidence was given that the contract for the ironwork for the extension of the works had been let to a firm who do not pay the minimum rate of wages of the town, in violation of the fair contracts clause. The society offered a vigorous protest against such firms being allowed to do Corporation work.

Liverpool Electric Supply Company, Limited.—The directors of this Company have issued a circular to the shareholders stating that the Act of Parliament confirming the sale of the undertaking to the Corporation of Liverpool has now received the Royal assent, and that the completion of the purchase will take place on July 1 next. On that date the Company will post to the shareholders cheques for £8. 5s. per share, being £8. 2s. in respect of capital and 3s. for dividend at the rate of 6 per cent. from January 1 to July 1.

Dover.—The Town Council have decided to send a deputation to towns where the overhead electric system of trams is in operation. It is estimated that to give a 10 minutes' service from the pier to Pencester-road, a 30 minutes' service to Maxton, and a 15 minutes' service to Buckland, they would require four motorcars and two trailers. The cost of haulage would be 1½d. per mile per car, working 12 hours a day (Sundays included). The cost of constructing the tramways, providing cars, etc., would be £23,000 for the three miles.

The Japanese Trade.—Mr. Longford, the British vice-consul at Tokio, thinks there is a great opening in Japan for electric machinery. Valuable contracts are often lost at present because it is impossible to obtain specifications and prices from England

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within the brief period usually allowed for tenders, and he urges that English manufacturers should keep experts on the spot, and that they should work in association either with resident British merchants in Yokohama and Hiogo, or with the great Japanese firms in Tokio now controlling the trade.

Pacific Cable.—In reference to the proposed Pacific cable between Canada and Australia, it is stated that the Canadian Government applied for *pro formâ* tenders from various firms with a view to ascertaining the cost. Eight routes were suggested. The shortest was 6,246 nautical miles, and the longest 7,145 nautical miles. The lowest tender for the longest route ranged from £1,517,000 to £1,880,000, according as the cable were a 12, 15, or 18 word per minute cable; and it provided for a cable ready for operation within two years from the date of the signing of the contract.

Huddersfield.—The minutes of the Electric Lighting Committee, which were passed at the quarterly meeting of the Council, showed that it had been resolved to remit £7. 7s from the original amount of £17. 17s., the charge made for the professional services of the engineer in connection with the installation of the electric light at the infirmary. Petitions were received from various Nonconformist Sunday schools and Bible classes against the running of Sunday trams. Much discussion ensued, and eventually the petitions were read, and referred to the Tramways Committee for consideration and report.

Calcutta.—*Indian Engineering* says: "We learn that a proposal for lighting Calcutta by electricity, and working the tramways by this agency, has been referred to the Government of India in regard to the question of using overhead wires to convey the current. This question is, of course, one of much consequence, both from the suppliers' and the public point of view, and we can quite understand the motives which have prompted the local Government to refer this matter to higher authority." It will be in the recollection of our readers that in our last issue we quoted a paragraph from another Indian paper which denied the above statement.

Beckenham.—At the meeting of the Urban District Council a communication from the National Telephone Company was submitted with a plan showing the position of intended posts to carry wires for fire-alarms and telephone purposes. It appeared from this plan that the company propose to carry the wires entirely on posts placed on the highways. The committee recommended that the subject stand over until this time next year, when the existing agreement will expire, and it may be necessary to make other arrangements. The company's tender for the required fire-alarms was £6 with overhead wires and £38. 10s. with wires carried underground.

Bucklow.—The Clerk stated at a meeting of the Rural District Council that in the agreement with the Altrincham Electric Supply, Limited, there had been an attempt to forestall the Council. The order as drafted, and which came before the Council some time ago, contained one section which was at variance with the terms of the agreement entered into between the company and the Council for the purchase of the undertaking. He had applied to have the terms of agreement incorporated in the Bill. It was stated that the section referred to would only give the Council power to purchase the length of main in Timperley. It was resolved to leave the matter in the hands of a committee.

Llandudno.—At the meeting of the Urban District Council, the Electric Lighting Committee recommended certain conditions relative to the appointment of Mr. A. H. Preece as electrical engineer, the main feature being a payment of 5 per cent. upon the accepted tender. In preparing the plans for the refuse destructor works the engineer was directed to take into consideration the possibility of taking the chimney underground to the top of Bryniau Hill, the site for the destructor to be the most suitable spot at the rear of the gasworks. Mr. Preece had accepted the terms, and the report was adopted. Mr. Joseph Hughes gave notice of motion that a committee be appointed to report as to a road or an electric railway up the Orme.

Cricket.—The Brighton Traffic eleven met the Electric eleven at Preston Park on Wednesday, and the match resulted in a win for the Traffic by 80 runs. Score: Traffic—Aldridge c Ewer b Bunny 33; Vinnicombe lbw b Goddard 19; Cheeseman b Bunny 2; Eames c Ewer b Steers 43; Benford b Steers 4; Sweetman b Butler 5; Moore c Gates b Steers 0; Gillham b Steers 2; Terry b Bunny 4; Johnson not out 0; Sinden b Bunny 0; extras 10—total 122. Electric—Gates b Cheeseman 8; Bunny b Cheeseman 5; Steers lbw b Aldridge 10; Hale b Aldridge 0; Brooks b Aldridge 0; Ewer run out 0; Barnes lbw b Cheeseman 1; Goddard not out 12; Bristow b Aldridge 0; Butler lbw b Cheeseman 0; Martin b Aldridge 1; extras 5—total 42.

Bury.—A deputation from the Bury, Rochdale, and Oldham Tramway Company recently approached the Tramways Sub-Committee with the object of ascertaining "whether the Corporation would look with favour upon overhead electric traction, and on what terms the Corporation could supply power." This was reported to the Sewering, Paving, and Streets Committee, by whom it was resolved "that before any reply be given to the tramway company the Tramways Sub-Committee be instructed to visit Bristol, where the overhead wire system is most successful and in full operation, and report." The sub-committee accordingly proceeded to Bristol last week accompanied by the borough engineer (Mr. Cartwright). The matter is still in a preliminary stage.

Manchester.—According to a report which will shortly be submitted to the City Council, the working of the electric installation in Manchester during the past year has been remarkably successful. Fifty-one miles of single conductor have been laid during the last 12 months, and during the summer of this year it is intended to extend the mains along Great Ducie-street, Bury New-road, Corporation-street, Miller-street, Great Ancoats-street, Lower Mosley-street, Great Jackson-street, Upper Jackson-street, Ardwick Green, Upper Brook-street, and in Victoria Park. Application is about to be made to the Local Government Board for permission to spend an additional £100,000 in the extensions to the plant and mains. A profit of over £11,000 was made in this department last year.

Kingston-on-Thames.—The minutes of the Lighting Committee which were approved at the last meeting of the Council showed that the committee had decided to lay a cable for the supply of current in Queen's-road, Liverpool-road, and Crescent-road, at an estimated cost, with two transformers, of £220. The committee had inspected and approved a specimen street lamp fitted with two incandescent electric lamps, and decided that it should be erected in Pheasant-lane. Further correspondence had taken place with the Maldens and Coombe District Council respecting the laying of electric mains in Coombe, and the matter was still under consideration. The electric launch charging station being now ready, the committee had resolved to fix the charge at 1s. 3d. per unit. Nineteen tenders were received for the supply of coal, and the committee decided to order a sample barge of Messrs. G. E. Wood and Sons' Durham rough small at 10s. 9d. per ton.

Bedford.—At the meeting of the Urban Sanitary Authority the report of the Electric Light Committee, which contained the following recommendations, was adopted: "The Electric Light Committee recommended: (*a*) that the authority become annual subscribers of £1. 1s. to the Municipal Electrical Association; (*b*) that the Bedford Gaslight Company be again requested to remove forthwith their lamp standards from the various streets comprised in the area already lighted by electric lamps, and that unless such request be complied with the authority remove such standards and charge the cost thereof to the company; (*c*) that the common seal be affixed to the following contracts: Messrs. Easton, Anderson and Goolden, Limited, Messrs. J. Oakes and Co., Messrs W. H. Allen, Son, and Co., and Messrs. W. T. Glover and Co. The committee report: (*d*) that during the last two months applications have been received for the supply of electric current to about 550 additional 8-c.p lamps or their equivalent." Applications for the supply of current are coming in very well.

Portsmouth.—The Electric Lighting Committee's annual balance-sheet, made up to March 31, 1896, shows that the revenue for the year was £7,387, while the expenses came to £4,010, leaving a gross profit of £3,377, of which £3,300 has been carried forward to the account of interest on redeemable stock and mortgage debt and the loans fund account for redemption of capital, while the balance has been retained as a reserve to provide for bad debts. The two accounts named absorb £3,749, so that the net deficit on the twelvemonths' working, after the payment of all current expenses and of interest on capital and redemption of loans, is only £419. But in the last three months of the year the gross revenue was much greater than in the three preceding quarters, while the expenditure was reduced, so that for that period there was actually a profit on the entire working. At a meeting of the Electric Light Committee it was decided to place four arc lamps in Pembroke-road, Portsmouth, between the Common and the High-street. When this is done the whole of the current for arc lighting will have been utilised.

Kensington.—The Works Committee report that the lighting engineer has called their attention to overhead wires fixed by the National Telephone Company across Kensington High-street with a distance of 250 yards between the supports, the limit allowed by the London Overhead Wires Act, 1891, unless permission is obtained from the local authority, being 115 yards. The committee recommend that the vestry clerk be instructed to write to the National Telephone Company requiring them to comply with the provisions of the London Overhead Wires Act. The lighting engineer has called the attention of the committee to several electric arc lamps used for private lighting in the parish which are at a less height than 8ft. from the public way, and therefore contrary to the regulations made by the Board of Trade; and they recommend that notices be served for the alteration of the lamps in question. Notices and plans have been received from the House-to-House Electric Light Supply Company relative to extensions of their mains in Gloucester-road and Redcliffe-square; and the committee recommend that permission be given for the work being proceeded with subject to the usual conditions.

Kidderminster.—The Kidderminster and Stourport Electric Tramway Bill has been under the consideration of a Select Committee of the House of Commons. The Bill proposes to make a tramway from Kidderminster to Stourport at a cost of between £30,000 and £40,000, the capital of the new company to be £60,000 with the usual power to borrow £15,000. The only opponents were the Great Western Railway Company, there being no appearance on the part of the Kidderminster Gas Company, who originally petitioned against the Bill. Mr. Balfour Browne, Q.C., and Mr. Lewis Edward were counsel for the Bill, and Mr. Pollock, Q.C., and Mr. Lloyd represented the Great Western Railway Company. Mr. Balfour Browne, in opening the case for the promoters, said the tramway would be four miles long. The feeling of the district was very much in favour of the line, and the consent of the road authorities had been obtained. Certain public improvements in the way of bridge widenings at Kidderminster and Stourpoint would be carried out. The gravamen of the Great Western Railway Company's complaint was the use of elec-

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tricity at the crossing of the Severn Valley Railway on the level. Whatever danger by leakage could happen to the railway company could be entirely removed by the erection of a wire at a cost of £12. Mr. Garcke, one of the promoters of the Bill, and director of the British Electric Traction Company, said the gross revenue from the line was estimated at £10,000, and the working expenses would not exceed 60 per cent. of the earnings. Mr. J. L Owen, of the firm of Messrs. Dickenson and Co., engineers, Birmingham, engineer to the scheme, said the line would be constructed as an ordinary tramway. The committee decided to allow the Bill to proceed, subject to the insertion of a clause imposing an obligation on the tramway company to contribute an amount to be decided by the Board of Trade, but not exceeding £750, towards the construction by the railway company of a bridge at the present level crossing when public necessity demanded it.

Brighton.—At the last meeting of the Council the following proceedings of the Electric Lighting Committee were conformed without discussion: "This committee meeting on May 4, resolved that electricity mains should be laid as follows: in Grenville-place from Russell-street as far as No. 36, at an estimated cost of £40; in Carlton-hill from Grand-parade as far as No. 27, at an estimated cost of £200, and that the street lamps along the line of such main be fitted with incandescent electric lamps; in Eaton-place from St George's-road as far as No. 42, at an estimated cost of £25 and that the street lamps along the line of such main be fitted with incandescent electric lamps. At a meeting of the committee on May 11, tenders for the supply of armoured and unarmoured lead-covered cables during the year ending May 1, 1897, were submitted, and that of the Callender's Bitumen Telegraph and Waterproof Company, Limited, London, was accepted at the following prices: unarmoured cable—size, ·008; price per rink, £28 · armoured cable — price per mile ·017 square inch cable, £74; price per mile ·05 and ·03 square inch concentric cable, £242. Tenders for the supply of fittings for street lamps were also considered, and the committee resolved to accept that of Messrs. Skeats and Co, Queen's-road, Brighton, to execute the work of fitting up 450 street gas lanterns for incandescent electric lamps in accordance with the specification prepared by the manager of the electricity works, for the sum of £180, with a further price of 8s. for each additional lantern fitted up. Three additional gas lamps were ordered to be erected in Cleveland-road. A letter was read from Mr. J. Penny, stating that he is willing to guarantee the payment of 20 per cent. per annum on the cost of laying an electricity main in Islingword-road as far as his premises, No. 126 in that street. Resolved, that Mr. Penny's offer be accepted, and that the manager be instructed to lay a main from Lewes road as far as 126, Islingword-road, and that the public lamps along the line of such main be fitted with incandescent electric lamps."

Stafford.—The Gas and Electricity Committee submitted their annual report to the Council at the last meeting, for the year ended March 31. It stated that the quantity of gas made during the year was 145,055,000 cubic feet, being an increase on the previous year of 7,045,000ft, or 5·10 per cent. For the first nine months of the year the consumption was at a much greater rate, but owing to the mild weather of the last quarter this increase was checked to a great extent, or the total consumption would have been very much larger than what was now reported. The increase in the receipts for gas was £345. 12s. 9d, and for tar £190. 10s. 9d., and the cost of coal (notwithstanding the large increase in the quantity of gas made) was £537. 17s 5d. less than last year; but owing to the very low prices of coke and sulphate of ammonia (which yielded £535. 0s. 11d. and £465. 19s. 10d respectively less than last year), as well as increased working expenses, the profits were considerably reduced. The receipts were as follows: gas, £17,242. 8s 10d.; coke, £2 254. 0s 8d; tar, £939. 12s. 3d; sulphate, £517. 15s. 7d.; spent lime, £34. 0s. 5d.; and profit on fittings, £134. 10s. 11d.—making a total of £21,122 16s. The total expenditure was £14,066 2s., leaving a gross profit of £7,066. 14s., or £756 2s 11d. less than last year. Out of this amount the large sum of £5,401 3s. 8d. had been paid for interest and redemption of loans, and £261. 1s 2d. for income tax, leaving £1,394 9s. 2d. as the net profit of the year. The sum of £197. 5s. 2d. was brought forward from last year, so that £1,591. 14s. 4d. was the amount now available for disposal. The committee recommended that £1,500 be transferred to the district fund in aid of the district rate, and that the balance, £91. 14s. 4d., be carried forward. The loans repaid now amount to £25,795. 0s. 2d. and (including this £1,500) £26,850 had been handed over in relief of the rates The consumption of gas for cooking, etc., was steadily increasing, and the committee hoped that it would not have to report any diminution whatever on account of the competition of the electric light. With regard to the electricity department, the committee had only five months' actual working upon which to base a report, and it would manifestly be unwise to draw conclusions as to the future until a full year's experience had been obtained. So far, however, everything had been exceedingly satisfactory. No hitch whatever had occurred anywhere, the number of consumers was increasing, and the accounts showed a net credit balance of £296. 11s. 6d. This the committee regarded as very encouraging, and recommended that the whole amount be carried forward to next year. Every indication pointed to the wisdom of the Corporation having control of both systems of lighting, and to their being under the care of one manager and one committee, by whom it was confidently hoped that each system, with its large financial obligations, might prove highly successful and beneficial to the town. In moving the consideration of the report, Alderman Peach said for the first time the accounts had been made up to March 31 instead of March 25, so that they had a week's extra expenditure without the corresponding income. He was pleased to be able to report a continued increase in the quantity of gas consumed, and there appeared to be every reason for believing that the consumption would go on increasing, especially as they had sent out three times as many gas-cookers as in the previous year. After alluding in detail to the report, he said with regard to the coming year the committee had received six tenders for the purchase of their gas-tar but none of them were considered satisfactory. One firm offered considerably higher terms than the others, but they required the committee to erect tar-distilling plant, and this proposal had been referred to a sub-committee to consider. As to the complaints about the stop-pipes at the gasworks the manager had devised a scheme by which the number of stop-pipes had been reduced more than 80 per cent. With regard to the electricity department, although there was a net credit balance of £296. 11s 6d, the actual profit on working expenses was £54. The report was adopted.

Hastings.—The Town Council have decided to lay down an electric light installation. The Public Lighting Committee reported at the last meeting of the Council that, in view of the expiration on July 1, 1897, of the existing contract with the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, for the lighting of the electric lamps on the front line, which they had reason for believing the company would not be prepared to renew for a further period except at a much higher charge per lamp than is at the present paid—viz, £25 per lamp per annum—they had had under serious consideration the question of the desirability of the installation by the Corporation of an electric light system of their own, under the provisional order granted to the Corporation in 1890, which conferred powers for the lighting of public streets and buildings. In accordance with their instructions, the borough engineer prepared plans, and submitted to them a report on the matter, in which he strongly advised the Corporation to undertake their own street, etc., lighting; suggested that the site of the old No. 1 pumping station, at Waterworks-road, adjoining the railway, which is the property of the Corporation, should be utilised for the establishment of a generating station, and that duplicate plant (to consist of two Babcock boilers, three compound steam dynamos and exciters, each capable of maintaining 35 arc lamps, with the necessary switch-boards, testing apparatus, etc.) should be provided, which plant would be sufficient to enable considerable additions to be made to the present number of arc lamps in the town, and to supply current to the town hall, the Brassey Institute, the stoneyard at Queen's-road, and other buildings belonging to the Corporation; pointed out that under provisions of the existing contract with the electric light company the Corporation are, if they themselves determine to undertake the public lighting, bound to take and pay the company for the standards, lamps, cables, pipes, and all other apparatus appliances, and materials relating solely to the public lighting (other than machinery, plans, etc.), by a valuation to be made in the usual manner; and put the estimated cost of an installation on the "alternate transformer system" (that adopted by the electric light company), complete in every respect for maintaining 70 arc lamps and duplicates—including the purchase of the company's plant—at £7,560, and the estimated annual cost of running 50 arc lamps, including interest at 3 per cent. and sinking fund, ample provision for maintenance, deterioration of machinery and lamps, etc., at £1 629, equalling £32. 15s. 7d. per lamp per annum, which annual cost, he intimated, would not be much increased were additional lamps lighted, as the extra cost would simply consist of a small increase in fuel, and the maintenance of the lamps, transformers, etc. It was ascertained that the company would not renew the existing contract on the same terms, but would be prepared to supply energy for the lamps at 5d. per unit, to include cleaning, maintenance, and all charges. At this charge it was calculated that the annual cost of each lamp of the present power kept alight till 11.30 would be £35 and kept alight all night £47, representing an average annual charge of £41. 5s. per lamp, or £16. 5s. per lamp per annum in excess of the present charge. The present annual cost of lighting by gas and electricity the front line and other streets, localities, public buildings, etc., which the committee recommend should be lighted entirely by electricity under the proposed scheme, amounted to £1,902. 10s., but if to this amount is added the increased charge of £16. 5s. per lamp per annum which would be made by the electric light company at the expiration of the existing contract, equalling £845, a total future annual cost of £2,747. 10s. is arrived at. The estimated annual cost of lighting the same streets, buildings, etc., wholly by electricity under the proposed scheme is as under: borough engineer's estimated annual cost of proposed installation (for 50 arc lamps), including charge for interest on loan and sinking fund, £1,639; lighting those portions of the town hall and Brassey Institute now lighted by electricity at, say, 4d. per unit, as against 9d. per unit now charged by the company, £53; lighting the gas lamps and the buildings, etc., above specified, now lighted by gas, £311—total, £2,003. It would be seen from these figures that the carrying out of the scheme would effect an annual estimated saving in the future cost of the lighting of £744. 10s., and the committee, having regard to all the circumstances, recommended that an installation on the lines indicated in the report be established forthwith, and that application be made to the Local Government Board for sanction to the borrowing of the estimated cost thereof—viz, £7,560. Councillor Idenden, as chairman of the committee, moved the adoption of the report. The Deputy-Mayor seconded, and said with regard to the machinery they intended to put it in on similar lines as they had at Tunbridge Wells. As to the present

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system by which lamps were laid, it was an expensive one, but they intended to keep these as at present, and when they were worn out there would doubtless be improvements in electricity. At Brighton they had the overhanging lamps, which was a better system than they had at present. The report was adopted unanimously.

PROVISIONAL PATENTS, 1896.

MAY 18.

10669. An electrical variable speed gear. Anthony George New, The Voltage, Woking, Surrey.

10670. An electrical variable speed gear. Anthony George New, The Voltage, Woking, Surrey.

10698. Improvements in or applicable to electric alarum apparatus. Henry Charles Bird, 322, High Holborn, London.

10718. Improvements in the manufacture of positive lead electrodes for electrical accumulators. Henri Owen Tudor, 4, South street, Finsbury, London.

10720. Improvements in electrically braking railway vehicles. Illius Augustus Timmis, 2, Great George-street, Westminster.

MAY 19.

10772. Improvements in starting and stopping devices for electrically-operated elevators. Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Bros and Co, United States) (Complete specification.)

10781. Improvements in apparatus for the application of electricity to vehicles driven by mechanical means. Herbert John Dowsing, 24, Budge-row, London.

10788. Improvements in electric arc lamps. Ernest John Bagnall, 18, Buckingham-street, Strand, London. (Complete specification.)

10803. Improvements in or applicable to apparatus for heating by electricity. Edward Davies, 5, Market street, Manchester.

10804. Improvements in electric railways. Henry Harris Lake, 45, Southampton buildings, Chancery-lane, London. (Edward Hibberd Johnson and Robert Lundell, United States.) (Complete specification.)

10811. Improvements in the production of electrodes suitable for secondary batteries. Augustus John Marquand and Emmanuel Hancock, 24, Southampton-buildings, Chancery-lane, London

10816. Improvements in electric measuring instruments. James Devonshire, 70, Chancery-lane, London (Elihu Thomson, United States) (Complete specification.)

10817. Improvements in and connected with electric brakes for electrically-propelled vehicles. James Devonshire, 70, Chancery-lane, London. (William B Potter, United States.) (Complete specification.)

10818. Improvements in contact making and breaking devices at drawbridges in the overhead circuit of electric tramways. James Devonshire, 70, Chancery-lane, London. (William B. Potter, United States) (Complete specification.)

10846 Improvements in or relating to magnetically affecting the counter electromotive force of the voltaic arc of an electric arc lamp. William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Lewis Coffin, United States.) (Complete specification.)

MAY 21.

10906. Improvements in and connected with electrical traction. William Kingsland, 33, Chancery-lane, London.

10948. Automatic gear for making or breaking or both making and breaking electrical contacts at given times, which times may also be varied at will. Frederick Brown and Charles Herbert Offord, Fairyfield, Highgate, Walsall.

10949. Improvements in the application of electrical motive power to cycles and road vehicles. Robert Owen Allsop, 37, Norfolk-street, Strand, London.

10988. Electromagnetic gearing. David Cook, 30, Lancaster-park, Richmond, Surrey.

10993. Improvements in electric incandescent lamps. Ernest Bailey and John M. Symington, 47, Waterloo-street Glasgow.

11035. Improvements in the manufacture of electric insulation tubing and electric insulators. Frederick Gwilym Treharne, Wrangbrook, Llanishen, near Cardiff.

11056. Improvements in the means of lubricating the bearings of motor cars or auto-motors. Ernest John Clubbe, Alfred William Southey, and the Electric Motive Power Company, Limited, 55, Chancery-lane, London.

11058 Improvements in motor cars or auto-motors, applicable also to launches. Ernest John Clubbe, Alfred William Southey, and the Electric Motive Power Company, Limited, 55, Chancery-lane, London.

MAY 22.

11133. Improvements in or connected with apparatus for the electrolytic decomposition of liquids. George Bell and George William Bell, 15, Water-street, Liverpool.

11162. Electric alarm apparatus. Frederick William Golby, 36, Chancery-lane, London. (Heinrich Winter, ———.) (Complete specification.)

11176. Improvements in electrical boilers for heating water and other liquids. John Chambers, 7, Staple-inn, London. (Date applied for under Patents, etc., Act. 1883, Sec. 103, December 5, 1895, being date of application in New Zealand.)

11212. Improvements in dry cells for galvanic batteries. Thomas Clark, 24, Southampton-buildings, Chancery-lane, London.

11216. Improvements in electro-chemical apparatus. Chester Dawson, The Mount, Hampstead, London. (F. Manza, Austria.)

11230. Improvements in electrical regulating apparatus for arc lamps. Henri Pieper Fils, 47, Lincoln's-inn-fields, London.

11232. Improved electric current conducting apparatus for electric railways Carl Friedrich Phillipp Standebach and Oskar Hermann Linker, 18, Buckingham-street, Strand, London. (Complete specification.)

MAY 23.

11249. Improvements in the method of and apparatus for driving electric cars. William Griffin, Commercial-street, Halifax.

11329. Improvements in electric railway signals. Wilhelmine M. Klees, 126, Carlton-vale, Maida Vale, London.

11338. Improvements in electrodes for electrolytic purposes. Ernest Auguste Georges Street, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1895.

8696. Electric distribution. Wright and Quin.

11233. Arc lamps. Peschek.

12035. Cutting off gas or electric current. Phipps.

24375. Electric arc lighting. Hegner.

1896.

977. Synchronising alternating-current motors. Parshall.

2003. Telegraph repeators. Lake. (Merritt.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	6¾-6½
Brush Company, Ordinary	3	1¾-1⅞
—— Non. Cum., 6 per cent. Pref.	2	1⅞-1¾
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	8½-8¾
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7⅛-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16½-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	15-15½
County of London and Brush Provincial Co., Ordinary	10	8½-9½
—— 6 per cent. Cum. Pref.	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1½-1⅝
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	1½-1⅝
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	⅞-1
Elmore's Wire Company	2	¾-1
Fowler-Waring Cables	—	—
W. T. Henley's Telegraph Works, Ordinary	10	16-17
—— 7 per cent. Preference	10	17-18
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	3⅜-3½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	—
Kensington and Knightsbridge Ordinary	5	9-9½
—— 6 per cent. Pref.	5	7½-8
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	17½-17⅞
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	1-1½
Metropolitan Electric Supply	10	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7½-7⅝
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6⅞
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	9-9½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5½
St. James's and Pall Mall, Ordinary	5	10½-11
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	6	8-8½
Westminster Electric Supply, Ordinary	5	9½-10
Yorkshire House-to-House	5	7⅛-8

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NOTES.

Dundee Institute.—An excursion to Inchcolm, etc., has been arranged for June 30.

Geneva Tramways.—The Swiss Federal Council have authorised the opening and working of three new electrical tramways in Geneva.

Sir George Stokes.—Sir George Stokes, Lucasian Professor of Mathematics at Cambridge University, has been elected an honorary member of the Austrian Academy of Sciences.

Chemical Society.—A meeting of the Research Fund Committee will be held in June. Applications for grants, accompanied by full particulars, should be sent to the secretaries before June 8.

The Amazon Cable.—The rates for telegrams to Souré, Mosqueiro, Pinheiros, Cametá, Breves, Gurupá, Chaves, Macapá, Monte Alegre, Santarem, Alemquer, Obidos, Parintins, Itacatiara, and Manáos on the Amazon have been published in the *Gazette*.

Royal Institution.—To-night (Friday) Prof. Fleming lectures at the Royal Institution on "Electric and Magnetic Research at Low Temperatures." With the exception of Mr. Martin's lecture on Niagara on June 19, this is the last of the Friday evening meetings.

Institution of Electrical Engineers.—There is to be a students' visit to the Bankside station of the City of London Company on June 10, at 7.30 p.m. Students desiring to take part in it should forward their names to Mr. G. C. Allingham, at Eldon House, Lyndhurst-road, Hampstead, N.W.

Calcium Carbide.—According to *Elektrotechnische Blätter*, the Swiss Federal Council have decided that carbide of calcium can only be received for carriage on the railways when packed in hermetically-closed iron cases, by which it is to be presumed only air-tight iron cases are meant. No other substances may be packed with the carbide.

Obituary.—The death has been reported of Dr. Henry C. Nicholson, who was prominently concerned with the invention of quadruplex telegraphy. Dr. Nicholson died at his home near Independence, Kentucky, at the age of 74 years. He received a stroke of paralysis about six weeks prior to his death, from the effects of which he never recovered.

New Cable to Germany.—The shore end of the new submarine cable to Germany was landed by the steamship "Silvertown" at Bacton, on the Norfolk coast, last week, and the "Silvertown" then steamed away in the direction of Germany, paying out the cable as she went. Mr. Lamb, assistant secretary of the General Post Office, superintended the arrangements.

The Telegraph Conference.—Mr. J. C. Lamb, C.B., C.M.G., Mr. H. C. Fischer, C.M.G., and Mr. P. Benton will represent the Government of this country at the international telegraph conference, which meets at Budapest on June 16. These delegates will also represent the Cape Colony and Natal. Mr. R. J. Mackay has been appointed secretary to the delegation.

Committee on Rails.—The President of the Board of Trade has appointed a committee, consisting of Lord Blythswood (chairman), Sir Benjamin Baker, Sir J. Lowthian Bell, Prof. Wyndham Dunstan, Prof. A. B. W. Kennedy, Major F. A. Marindin, Mr. E. P. Martin, Prof. W. C. Roberts-Austen, Dr. T. E. Thorpe, Prof. W. C. Unwin, and Mr. E. Windsor Richards, to enquire into the loss of strength in rails by prolonged use.

Street-Lighting.—The New York *Electrical World* states that arrangements have been perfected for a convention of the superintendents of street-lighting from all parts of the United States to be held in New Haven, Conn., this month. The plan is to have a two days' meeting of all the street-lighting officials and authorities for the benefit and mutual aid of every city which sends delegates. This will be the first convention of the kind held in the United States.

Sheffield Exhibition.—These columns have occasionally contained announcements of exhibitions to take place in various parts of the world which are not nearly so well known to Englishmen as Sheffield. That city was, however, to have had an exhibition of some kind or other this summer, but it does not appear to have come off. A site was secured, and, what is of equal importance, exhibitors were believed to be ready, but the exhibition has not been opened, nor, so far as it can be ascertained, is it likely to be at present.

Accidents in France.—It appears to be considered across the Channel that if an accident happens there must be someone made responsible. A peasant having been killed and another seriously hurt by coming in contact with overhead wires which had been blown down by a storm, two of the managers of the electric works at Saint Victor-sur-Loire were placed on their trial before the Correctional Court on a charge of killing and wounding by neglect. The Court, however, promptly acquitted them.

Brush Electrical Engineering Company.—We have received from the Brush Electrical Engineering Company, Limited, a copy of the second edition of their book of working instructions for the use of their plant. This is a well-turned-out little volume, morocco bound, with soft covers and rounded corners so as to adapt itself to the pocket of the electrical engineer, where, doubtless, it will be found in all stations using the Brush Company's machinery. The 63 pages of descriptions and instructions for use could hardly have been issued in a more convenient form.

Swiss National Exhibition.—It is a common complaint that exhibitions are opened long before most of the exhibits are in place and ready for inspection. It may, therefore, be of interest to visitors to Geneva to know that, according to the *Revue de l'Electricité* of May 31, sections 29 and 38 (machinery and industrial electricity) are sufficiently complete to repay inspection and study. Among the exhibits it may be noted that the Oerlikon Company show a 750-h.p. continuous-current dynamo designed for electro-metallurgical work. An interesting feature of the section will be the triphase and polyphase motors of various makers.

Book Received.—We have to note the receipt from Messrs. Whittaker and Co., White Hart-street, Paternoster-row, of "Engineer Draughtsmen's Work." The author, "A Practical Draughtsman," is anonymous, and the object of the little book is to provide a quantity of hints and information likely to be useful to the large number of aspiring young men in schools and workshops who desire to obtain entrance into drawing offices, but who are often in considerable ignorance of the work that is really carried on in such places, of what will be required of them when they get there, and the instruments and appliances which they will need to be familiar with.

Insulating Material.—From a French source, it appears that an insulating material for wires is manufactured by Anderson, of Stockholm, by treating a fatty oil—such as resin oil—with 20 to 30 per cent. of concentrated sulphuric acid at a low temperature. To this

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is added cellulose or moistened cotton, and the whole is heated to 110deg. C., and pulverised sulphur is added, which is followed by a reaction which completely changes the consistency of the material. A further large quantity of sulphur is added, and the material is then poured into cold water, after which it is rolled between cylinders and combined with rubber, guttapercha, resin, or paraffin, according to the purpose for which it is to be used.

The Kelvin Jubilee.—The Senate of the University of Sydney, N.S.W., have appointed the chancellor, Sir William Windeyer, LL.D., and Prof. Liversedge, M.A., F.R.S., the dean of the Faculty of Science, who are at present in England, to represent them at the University of Glasgow on the occasion of the Kelvin jubilee. We gave last week the programme of the celebrations. As it will be impossible for all the students and student delegates from foreign universities to be present at the conversazione on June 15, the joint committee of the Students' Representative Council and the University Union have arranged as an alternative for a smoking concert at the Union. Mr. H. Goodman is the secretary of the committee, and applications should be addressed to him.

Helium.—Argon and helium have from the first acted very improperly from the theorists' point of view, in that they have consistently behaved like monatomic gases, while if that supposition is adopted it is impossible to find any place for them in the Mendeleief arrangement of the elements. Prof. Ramsay has now discovered that helium diffuses more rapidly than from its density it ought to do, a result which may be at once correlated with its abnormally high conductivity. Evidently what are practically first approximations will no longer do, and the whole of the kinetic theory of gases will have to be overhauled and brought up to date. In one way and another, it would seem that the "mathematics and physics" people have plenty of work before them.

Canal Traction.—It is stated in *L'Electricien* that the Administration des Ponts et Chaussées of the French Government have under consideration the establishment of a system of electric traction on the River Lot, which will take barges up as far as the Aveyron coalfields. Water power from the natural fall of the river is to be used to generate the current, and it is considered that the installation of some such system of barge traction is the only means of reviving the navigation of the river, which has greatly fallen off. On the other hand, as the Aveyron coalfields produce more than a million tons of coal a year, it is thought that it would be a matter of great importance to establish a convenient and cheap system of water communication between them and the district and port of Bordeaux.

Church-Lighting Extraordinary.—At St. Ignatius's Church, in Hayes-street, San Francisco, about £6,000 has been spent in obtaining stained-glass windows from Germany, and now it is found that it is no good, since at the evening service, which is the important one in most American churches, no one can see them. As an American contemporary puts it, "Owing to the construction of the church, their beauty is absolutely lost after dark." Probably the architect is not very much in fault, as most churches are constructed in that way, but, all the same, the Californians do not intend to go without a show for their money. Consequently they have called in the aid of the electric light, and fixed arc lamps outside the windows. The congregation appeared to have liked the effect so much that the arrangement is to be a permanency, and the church authorities are now discussing the best arrangement of reflectors.

Chicago Tramways.—From statistics issued in Chicago, it appears that 10 years ago there were but four tramway companies in Chicago, capitalised at 11,437,000dol., and working a street mileage of 90 miles. To-day there are 10 distinct corporations engaged in local transportation business, having an aggregate capitalisation of 187,208,000dol., and operating 32 miles of street mileage. Of the four systems in existence 10 years ago, three were worked entirely by horses, the fourth using both cable and horses. Now the horse car has practically disappeared from Chicago, the motive power at present being—Surface roads: electric, 255 miles; cable, 42 miles; horse, 18 miles. Elevated roads: electric, 15 miles; steam, 11 miles. In addition to the roads now completed, construction work is rapidly progressing upon five surface and elevated roads, all to be worked by electricity, and which will, when completed, increase the total city mileage to 400 miles.

Semaphore Signalling.—We have received from the author, Captain C. Vreede, who is a retired commander of the Dutch Royal Navy, a pamphlet on a so-called international code of signalling. The main feature of the pamphlet is a proposed alteration in the code to be used, by which the Morse code is rejected in favour of the signals afterwards described. We have carefully read the author's justification of his proposed change, but the evidence brought forward does not seem to be by any means sufficient to warrant the departure from the Morse code now that the latter has secured almost universal acceptance. Apart from this radical fact, the pamphlet shows that the author has devoted much time and careful study to perfect his system and the various mechanical apparatus used in it. It is a pity, however, that more care has not been taken in the translation of the pamphlet into English, as some of the sentences in it are at present unintelligible. Sound and night signalling gears are also described.

Tramcars and Lightning.—The erratic ways of lightning have always been proverbial, and even the best-devised lightning-arresters cannot do everything. A case has been reported from New Brunswick, in the State of New Jersey, in which a trolley car was struck by lightning on the afternoon of May 5 during a thunderstorm. According to the *Scientific American*, the discharge passed down the trolley pole and entered the car, part of the current running on to the lighting circuit and burning out the incandescent globes. "So intense was the heat in the lamps that the glass globes melted; most of the glass fell on the floor, but other drops went into the laps of women and more fell on their hats. The ladies thought they had cause for complaint, and demanded that the company should make good the damage to their garments." It is satisfactory, however, to see that, even if a lightning discharge or a portion of it does get into an electric tramcar, the danger of the passengers is confined to the risk of broken glass.

American Electric Trams.—The *Times* has published a letter from "Union Jack," who, writing from Kingston, in the State of New York, wishes to warn Englishmen against adopting electric traction on tramways on account of its danger. "Union Jack" has apparently been frightened by the Brooklyn tramcars, which are notorious even in America, and hopes that "every effort will be made to keep these death-dealing vehicles out of the Metropolis." In the course of his letter, "Union Jack" shows that he has no technical knowledge of the subject, and therefore it is not very wonderful that he has failed to see that the perils he fears are simply due to the American way of doing things, and not in any respect to the inherent dangers of the system. Yet, curiously enough, he puts his finger on the exact spot when he says,

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"Over here (*i.e.*, in New York) the almighty dollar rules the roost, and life and safety are a secondary matter." The attitude of the people who are utterly careless of old and known dangers, but panic stricken at the hint of a new one, is eminently absurd, but it has to be reckoned with; and bad as is the record of the Brooklyn trams, it would look very different when compared with the record of cart and cab accidents during the same period. The different ideas on the subject of safety which show themselves in the working of English and American railways would undoubtedly have the same effect in tramway working.

A New Education Scheme.—In an age of payment by results and of competitive examinations in educational work there is a tendency to act as though all boys may be ground into one mould. It would be so convenient to the educator if it were so, and as things are it may even pay him best to throw out the specimens he cannot so mould as "wasters." Some remarks of Mr. Charles Bright on the subject in a short leader in the *Referee* may therefore be worth consideration. The man best qualified to pass examinations with high honours may be the least fit to teach others, as he is apt to attach undue importance to his own method of obtaining success. In Mr. Bright's system, as we understand it, a liver test would be employed simultaneously with that on literary subjects. Then the boy whose health is affected least by the application to hard brain work would receive a large bonus in marks. The main feature of the proposed system is, however, the selection of real live men as masters rather than the bookworms with high university degrees—a man with a business knowledge of the world and a healthy physique, who, having a knowledge of the relative values of study and manliness, can train the boys under their charge and bring out the good points in each. At the same time they could acquire a knowledge of the capabilities of each, and check the tendency which leads so often to a useless life after a school career full of success. The boys then would have a chance of entering a profession to which they had shown some aptitude, and the dangerous and costly change from one career to another later on in life would be avoided.

Telegraphic Communication.—The fool's paradise in which we are dwelling in this country in reference to the integrity of our telegraphic communications in case of war has more than once been dealt with in this journal. Somewhat similar views have been strongly enforced by Mr. Percy Hurd in the current number of the *Contemporary Review*. There are, he says, two telegraphic routes with South Africa, the East Coast and the West Coast. The East Coast line touches Portuguese territory at three points; the West Coast touches both Portugal and Porto Novo, which belongs to France, and, moreover, passes through a region where white labour is almost impossible. Three sections of the West Coast route were in January, in the midst of the Transvaal difficulty, interrupted by the burning of rubbish at the water's edge. Mr. Hurd appends a formidable table of interruptions in both routes during the last six years, from which it appears that the East Coast route was on one occasion interrupted for 114 days in succession; the West Coast route having once been interrupted for 50 days. Nor are things so very much better as concerns our other colonies. "No single possession in east longitude is connected telegraphically with London without the passage of the wires over some foreign territory, or their landing at a number of foreign ports." With the West Indies our communications are equally at the mercy of other people. "To reach Jamaica, Barbadoes, and Trinidad, British messages must pass over United States land lines, and thence *viâ* Cuba or *viâ* Galveston (Texas) and Panama, through revolution-ridden republics in Central America." War with the United States would find the islands of the West Indies cut off from us. Such a danger ought to be met by the construction of all-British cables, and Mr. Hurd endeavours to show that the cost is not prohibitive, and that our Colonies are quite willing to contribute to it.

The Pacific Cables.—The Imperial representatives on the committee of enquiry into the scheme for connecting England with her Australasian colonies by telegraphic cable, *viâ* Canada and the Pacific, have not been definitely appointed, but it is probable that Lord Selborne, Under-Secretary of State for the Colonies, will be one of the two, and that there is a feeling in favour of requesting him to preside over the deliberations of the committee. It is intended to hold two meetings of the full committee as soon as may be to settle questions of principle, but the Australian delegates — namely, Sir Saul Samuel and the Hon. Duncan Gillies—will then have to leave to attend the Telegraphic Conference at Budapest. The meetings of the committee will be as informal and business-like as possible; and they will not be open to the Press. Meanwhile the rival Pacific cable from the United States to Japan appears to be getting on. We noted at the time that it had passed the Senate, and the Committee of Commerce of the House of Representatives have now authorised a report to be presented in favour of the Bill, which provides that the American Postmaster-General may contract with the Pacific Cable Company of New York for the construction of a cable from the United States to Hawaii, Japan, and China, *viâ* the Medway Islands. In one way or another the Americans, who are fond of doing such things, will soon be able to send a telegraphic message round the world from one side of a dinner table to the other instead of having to be content, as at the opening of the New York Exhibition, with a long loop to Japan and back again.

Electric Traction on Railways.—We have repeatedly referred to the interest taken in America on the subject of the application of electric traction to ordinary railway working and the care with which every possible saving that might follow the adoption of this method has been discussed in the technical Press. It seems that the *Canadian Engineer* is even more sanguine on the subject than its contemporaries in the States. In this month's issue of that journal Mr. J. H. Kelley is responsible for an article which begins as follows: "It is difficult to move people out of the beaten track, and after 50 years' experience of steam traction for railways, it is only natural that the idea of employing electricity as a substitute for steam should be a little slow in making its way. It may not be long, however, before we see most of the railways now operated by steam locomotives adopt electricity as a means of traction, distributing it from a series of central power stations at suitable distances apart. Among the advantages of this system of operation would be the economical production and distribution of power from a station for a stretch of road on each side. There will be a pair of condensing engines, or, more economical still, a gas-engine, using about one-fifth of the fuel required by the locomotive of the best type. Each pair of engines would handle six passenger or freight trains, thus making two cylinders do the work that now requires 12, the labour of six engineers and foremen being replaced by that of half that number. The locomotive is not economical either in the production of steam in the boiler or in distributing it as power. In the locomotive the ratio of expansion at slow speed is very wasteful, and under the changing conditions of load and weather it is not possible to run the locomotive economically. On the other hand, the automatic cut-off

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compound engines attached to the latest design of dynamo placed direct on the shaft can in most instances be relied upon to generate 1 h.p. per hour per 2lb. of coal."

High-Voltage Lamps.—The New York *Electrical Engineer*, which has reprinted in full Mr. Addenbrooke's Institution paper on high-voltage lamps, regrets that the subject was not touched upon during the discussions at the recent meeting of the National Electric Light Association at New York. From the steadily increasing use of 220-volt incandescent lamps, our contemporary considers that the inference is fair that with the lapse of time their employment will cause the general displacement of the time-honoured 110-volt lamp. It is, however, pointed out that at the same efficiency a 220-volt lamp must have a filament four times the resistance of a 110-volt lamp, and with the same surface. "This means a very long and very thin filament, and such filaments are at once difficult to make and hard to support in the bulb, owing to their great length and lack of stiffness. Regarding the efficiency of such lamps, the fact must not be lost sight of that, owing to their extreme thinness, these filaments are much shorter lived than the thicker 110-volt filaments at the same efficiency, and in order to render them commercially useful they are drawn to consume four watts per candle. This lower efficiency makes the filament thicker, besides lowering its temperature of operation. These relations seem bound to exist in lamps made by the present methods, using hydrocarbon treatment, and any improvement which produces a good three-watt 220-volt lamp will probably make a corresponding improvement in the practical efficiency of the 110-volt lamp." Though it is not made in so many words, the natural inference from this would seem to be that in deciding whether in any particular case a voltage of 220 or 110 should be adopted, no allowance need be made for a probable improvement in the efficiency of the high-voltage lamp. The article closes with the statement that enquiry has developed "the fact that during the past year one company alone sold 10,000 240-volt lamps, and that their quality is constantly improving, so that as good results are obtained in practice from a 240-volt lamp as from the 3·1-watt 110-volt lamp."

Town Telephone Wires.—Some interesting particulars have been obtained by Mr. Gordon, the town clerk of Aberdeen, as to the conditions under which various town councils allow the erection of telephone poles and wires on and across the streets. Mr. Gordon has communicated on the subject with a number of towns in England and Scotland, and from a memorandum he has issued it appears that in Edinburgh a small charge is made for each pole and wire attached to the pole. The Glasgow Town Council do not allow telephone poles to be erected in public streets or lanes, but overhead wires are fixed on the buildings in the streets by arrangement with the proprietors, and without permission from the Corporation, except in the case of buildings belonging to the Corporation. In Dundee a charge of 1s. per pole per annum is made for permission to erect poles in the streets. In Birmingham the wires are all laid underground, as the Corporation object to the erection of poles in the streets. In Bradford a charge of £5 per annum is made for leave and license, and 1s. per annum for each pole placed in a public thoroughfare. Only in exceptional circumstances is permission given for the erection of poles in public streets in Brighton, and in these cases a charge of 1s. a year for each pole is made. In Bristol the Telephone Company is charged 20s. per annum for each pole they erect in the public streets, and the Corporation charges individuals 10s. per annum for every quarter of a mile of wire which crosses a public street. No special condition is attached to permission for the erection of overhead wires in Cardiff other than that contained in the Corporation by-laws, which provides as to the height at which wires are to be placed above the street. The rental charged in Leeds for poles and wires fixed in the highways is 20s. per mile per annum for not exceeding eight wires, and 2s. 6d. for each additional wire. The Corporation of Manchester do not sanction the erection of poles in streets except a few in the outlying parts of the city belonging to the Postmaster-General. In Newcastle a charge of 1d. per pole per annum is made, but overhead wires are not permitted in the central parts of the city. In nearly all cases it is stipulated that the poles must be removed if required by the Corporation.

Tramway Brakes.—It is remarked in *L'Electricien* that a tendency to an increased speed manifests itself whenever mechanical or electric traction is substituted for the old-fashioned horse-drawn tramcars. Speeds of 10 to 12 miles an hour have become quite frequent, and in a town these cannot be considered as other than fast. It consequently follows that the numerous stoppages and the obstacles in the way of street traffic, coupled with the increased weight of the new motorcars, which often carry also a trailing car behind, have obliged the tramway companies to supply their rolling-stock with brakes of considerable power, and so far as may be instantaneous action. The hand-brake having been recognised as too weak, it was at first endeavoured to apply to tramway work the well-known brake used on the Paris omnibuses. Excellent as this is in some respects, it had the fatal defect of only acting in one direction, so that in case of a stoppage in going up a steep incline there would be nothing to prevent the car starting off to run down backwards. Many proposals for electric brakes have been made, of which the majority work on the principle of cutting off the driving current and short-circuiting the motor. This is effective in a fashion, but the stoppage is not a quick one, since the braking effect diminishes with the speed. Moreover, nearly all the energy of the moving vehicle reappears in the form of heat developed in the coils, and these may therefore easily be damaged, while if resistances are thrown in to keep the current below a safe limit in this respect the braking effect is diminished. Moreover, the wheels may skid. The result is that it has been necessary to fall back on the solution of the brake question adopted by the railway companies, though with some modifications—namely, brake blocks acting on the tyres, and driven in one way or another by air pressure. As, however, it is difficult in any of these systems to entirely suppress a certain amount of air leakage, the cost of which would have to be reckoned with in tramway working, our contemporary refers at some length to what are called hydro-pneumatic brakes, the name being, as we consider it, a somewhat inaccurate one, as it is air and oil that are really used, and not water and air. As an example of these, the Boston Lombard Company's brake is chosen, in which a quantity of mineral oil is interposed between the compressed air and the piston which works the levers and rods acting on the brake blocks. The particular oil chosen is "valvoline," which is not only free from any difficulty in the way of freezing, but has advantages in the way of the lubrication of parts which be practically inaccessible for that purpose in the ordinary way. After some reference to the well-known points common to all air-brakes, our contemporary concludes with the remark that the hydro-pneumatic brake has given excellent results in working, and deserves to make its way in Europe.

Rontgen Radiations.—It is understood that among the select few in this country who are entitled to pro-

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nounce on the subject it has now been pretty generally agreed that the Röntgen radiations are really transverse vibrations which differ from light waves only in their being of extremely small dimensions. If that is so, the subject belongs no longer, except indirectly, to the domain of electricity, but must be classed under "radiation and light." It may be remarked that from the very first it was pointed out in this journal that there were what seemed to be conclusive reasons why the new radiations, whatever they were, could not be the longitudinal vibrations which their discoverer and many others believed them. But negative evidence of the "cannot be this, so it must be that" order, however cogent, is always less satisfactory than a direct proof. If they can be confirmed and repeated, this has been supplied to a certain extent by some experiments made by Prince B. Galitzin and Mr. von Karnojitzky, and communicated to the Imperial Academy of St. Petersburg. As the proceedings of this body are probably not very accessible to English readers, it may be mentioned that Prince Galitzin tried to polarise the Röntgen rays. First he used Nicol prisms, and naturally got negative results. Considering what was already known as to the properties of the new radiations, that was not surprising. Ultimately he fell back on exceedingly thin slices of green-brown tourmaline, which works on a different principle, and then got evidences of polarisation in the way of a greater apparent opacity when the tourmalines were crossed. As has been said before, the experiments require repeating, but if they are confirmed they settle the question. So far as practical matters are concerned, it is announced from Berlin that the General Electrical Association have succeeded in so improving the Röntgen process as to render it possible for the internal structure of the head, the larynx, and more especially the action of the respiratory organs and heart, to be observed direct on the fluorescent screen. Except in the case of the head, which, from the greater imperviousness of bone presents special difficulties, there is nothing particularly impossible in this. In reference to the head, however, it is to be feared that every anonymous photograph put forward as taken by the Röntgen method is not necessarily genuine. Finally, Mr. Edison has made a discovery. This is a new lamp, and consists apparently of a Crookes tube, about 5in. long, coated inside "with some kind of crystals easily obtainable, the exact nature of which the inventor refuses to disclose." Mr. Edison's favourite up to the present has been tungstate of calcium, but the description does not fit this very well. These crystals fluoresce and give off light when the discharge passes. The practical difficulties in the way of the use of the very high voltage current necessary for "vacuum tube" work are not mentioned. Of course, the thing is far from having attained a practical stage, but it is so very much easier to convert too short waves into longer ones than to change the too long (heat) waves into the shorter light ones that it is likely enough that some day a more economic lamp than the carbon filament one may in this way be attained. Nothing further has been heard from the Halle professor who thought he could see the Röntgen rays. This observation will probably have to go the way of the plate-box that perplexed the readers of *Knowledge*.

Alternate-Current Dynamo-Electric Machines. The paper on this subject by Dr. J. Hopkinson, F.R.S., and Mr. E. Wilson, read before the Royal Society, and abstracted from the *Phil. Trans.*, deals experimentally with the current induced in the coils and in the cores of the magnets of alternate-current machines by the varying currents and by the varying positions of the armature. It is shown that such currents exist and that they have the effect of diminishing to a certain extent the E.M.F. of the machine when it is working on resistances as a generator without having a corresponding effect upon the phase of the armature current. It is also shown that preventing variations in the coils of the electromagnet does not, in the machine experimented upon, greatly affect the result, and that the effect of introducing copper plates between the magnets and the armature has not a very great effect upon the E.M.F. of the armature, the conclusion being that the conductivity of the iron cores is sufficient to produce the main part of the effect. A method of determining the efficiency of alternate-current machines is also illustrated, and the results of the experiments for this determination are utilised to show that in certain cases of relation of phase of current to phase of E.M.F. the effect of the local currents in the iron cores is to increase instead of to diminish the E.M.F. of the machine. In algebraic discussions of the theory of alternate-current machines, it has usually been assumed that the E.M.F. due to the magnets is a periodic function, the same whether there is a current in the armature or not, and that the effect of the current in the armature can be represented by regarding the armature as having self-induction. It has been pointed out, too, that the coefficient of self-induction will generally vary with the position of the armature in the field. To state exactly the same thing in another way, it has been assumed that the E.M.F. of the magnets is a periodic function independent of the current in the armature, and that the effect of the armature current on the induction through the armature can be represented as an armature reaction which vanishes at the moment when the current in the armature vanishes. In machines as ordinarily constructed, the current in the magnet coils is not compelled to be constant, and any rapid variation of the induction in the magnet cores will induce currents in those cores. The variations in the current in the magnet coils and the currents in the cores both tend to annul the variations in the induction in the core arising from the current in the armature, but they will not tend to alter the average effect of the currents in the armature on the induction through the magnets. That there will be such an average effect is not difficult to see. Suppose the armature coils to be fixed in line with the magnets of the machine, any current in the armature will have its full effect in increasing or diminishing the field through the magnets. Suppose the armature coils to be fixed midway between the magnets, any current in the armature will then have practically little or no effect in increasing or diminishing the field through the magnets. If the armature be connected through resistance, inductive or non-inductive, and the machine run in the ordinary way, the current in the armature will lag in phase behind the E.M.F. The result is that when the armature is opposite to the magnets there is a current in the armature tending to demagnetise the magnets, and adding together the effects of the armature in all positions, there is an average effect tending to demagnetise the magnets. If the machine had a constant current round the magnets and divided iron in the magnets, this average effect, as well as its variations, can be fully accounted for; call it self-induction or call it armature reaction, as you please. But inasmuch as the variations are in part annulled by the variations of current in the magnet winding and the local currents in the magnet cores, we have a part of the diminution of the E.M.F. of the machine unaccompanied by retardation of phase of the current in the armature.

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A NEW TRANSMISSION DYNAMOMETER.*

BY S. W. ROBINSON, PROFESSOR OF MECHANICAL ENGINEERING, OHIO STATE UNIVERSITY.

In designing and equipping a machine shop, or, in fact, a manufacturing establishment of any kind, one of the first problems met with, as touching economy and efficiency, is the amount of power required to run the plant. In olden times when the teeth of gear wheels were chipped and filed, and engine cylinders were bored by pushing a hand tool along a plank, this expense was either boldly guessed at, or roughly estimated according to the number of men employed—1 h.p., for instance, being considered sufficient to drive a suitable number of machine tools to keep 10 men at work. In modern times, however, where every possible leakage must be looked to with the greatest care, it is not only desirable, but absolutely essential to the welfare of the concern that an accurate knowledge should be had of the amount of power developed by the motor and the amount required to drive each machine.

The only satisfactory method of ascertaining these quantities is by the use of some form of dynamometer—by which we mean an instrument or machine for measuring the power exerted by an engine or electromotor, or the amount of power consumed in driving a single machine or machinery plant. A dynamometer is primarily an instrument to measure the work done by an effort of some kind, the result being usually expressed in foot-pounds and given in a lump sum, as 10,000, meaning 10,000 foot-pounds: as in the case of the integrating dynamometer. But more frequently the result is a diagram area, as by the recording dynamometer, which area, when measured by duly considering the co-ordinates and determining the area, represents the foot-pounds. Thus, the steam-engine indicator is in one sense a recording dynamometer, because the pressure ordinates of the indicator diagram multiplied by the stroke abscissæ gives an area which represents the foot-pounds of work performed by the engine for the corresponding stroke of that engine.

Sometimes the pressure or force ordinates only are indicated by the instrument, the space ordinates, or abscissæ, being determined by some other means than by the so-called dynamometer. Thus the work done in drawing a plough along a furrow may be measured by observing at frequent equal intervals a spring dynamometer applied between the plough and whiffletree, while the distance, or space passed over by the plough at the same time, is measured by a tape line or similar means. Then, multiplying the mean tractile force, in pounds, given by the spring dynamometer, by the space in feet will give the foot-pounds of work which was required for turning the furrow by the plough and team, the entire work, friction, and all, being measured. An ordinary spring balance for weighing may thus be used for a dynamometer, from which it may seem that this instrument is named according to the service required of it, as spring balance, dynamometer, etc. Dynamometers are divided into two classes—viz., absorption dynamometers and transmission dynamometers, the former being specially adapted to the measurement of the power developed by motors, by absorbing or neutralising it, usually by friction, but not applicable for measuring the power required to drive a lathe or grinding-mill; while the second, or transmission dynamometer, is especially adapted for determining the amount of power necessary to drive a machine by measuring it while being transmitted to the machine. The transmission dynamometer may, however, be used also for ascertaining the power of motors, the instrument being applied near the motor and transmitting all its power.

According to Morin, the sensibility of a dynamometer should be proportional to the intensity of effects to be measured, and should not be liable to alterations by use. The indications of flexures should be obtained by methods independent of the attendance, fancies, or prepossessions of the observer, and should consequently be furnished by the instrument itself, by means of tracings, or material results, remaining after the experiments. The observer should be able to ascertain the effort exerted at each point of the path described by the point of application of the effort, or, in certain cases, at each instant in the period of observations. If the experiment from its nature must be continued a long time, the apparatus should be such as can easily determine the total quantity of work expended by the motor.

To meet these conditions various instruments have been designed by Morin, Webber, Briggs, Tatham, Brackett, Hartig, and others, all of which are sufficiently accurate for practical purposes. But, in addition to possessing accuracy, and the other qualifications already mentioned, a dynamometer should be simple in construction, light for transportation, quick in adaptation, easy to read, and the results such as can be rapidly converted into the horse-power transmitted, and, above all, the machine sufficiently cheap to be within reach of every manufacturer.

To this end, after a fruitless search in the market for a truly desirable instrument, the transmission dynamometer illustrated in Fig. 1 was designed and built by the writer for the testing laboratory of the Ohio State University, where it has done admirable service. This machine consists essentially of a supporting frame, or pedestal, a T-shaped arm carrying the driving mechanism, and a graduated scale or weighing apparatus.

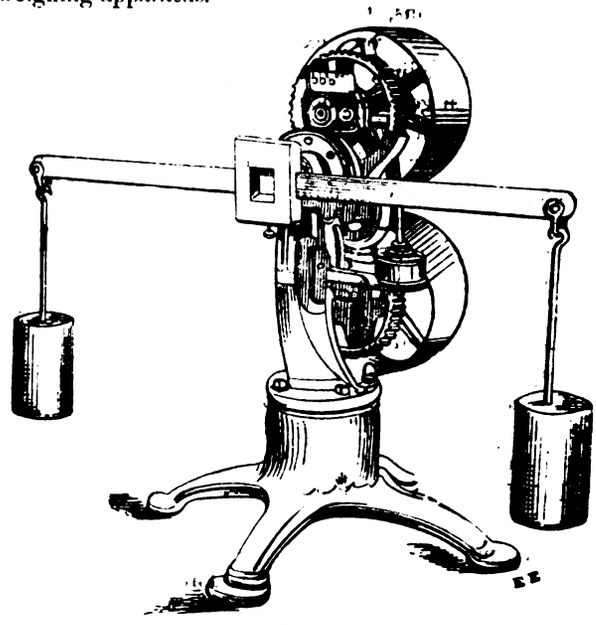

FIG. 1.

To use the instrument it is made fast to the floor with the pulleys under or to one side, but in the plane of the belt which drives the machine, the power to drive which is to be measured. Then with the machine set as shown in the illustration the lower pulley of the dynamometer is connected with the machine, while a second belt connects the pulley on the instrument with the pulley on the power shaft. This arrangement of pulleys enables the observer to connect his instrument without moving either the machine to be measured, or the driver on the main line.

The two pulleys of the instrument are mounted on a strong cross-tree bar so that they both overhang and can be swung around to any position. This overhang and swing makes it convenient to put either belt on or off without unlacing, and to swing the pulleys either way for tightening or loosening both belts. We may say, as a rule, both belts, for in setting the instrument up we can so set it, both as to location on the floor and position of cross-tree bearing, that by swinging the cross-tree one way we tighten both, or the other way loosen both belts. This movement of the cross-tree is made possible, and even convenient, by the cylinder and flange connection to the head of the column, the latter having screws and slots covering the full circle, so that the cross-tree may be set free to turn, and again made fast in any desired position. Thus the two pulleys may be swung about to any position in the whole circle to suit the particular location in hand. In swinging the pulleys and cross-tree thus, the set screw, making fast the poise-bar, should be slackened and again tightened when

* From *The Digest of Physical Tests.*

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the desired position is found. Thus the driving belt may come down from above, from the one side, or from below to its proper pulley on the short arm of the cross-tree; while the pulley on the longer arm is to be connected to the machine to be measured, the cross-tree being first set, if desired, so that both belts are loosened or tightened simultaneously, due regard being paid to the poise-bar set screw.

Sometimes it may be desired to slacken up for conveniently laying off the belts, as well as to tighten them. This feature of perfect adaptation for tightening or loosening the belts has been found a most useful one in practice with this dynamometer, as the belts can always be given the necessary tightness without going beyond the most suitable conditions.

The pulleys have each a gear on the end of the hub, both of which mesh into a smaller gear between, the latter being supported on a pin made fast as a crank-pin in the arm from a shaft which passes through the centre of the hub of the cross-tree in the head of the main column. To the opposite end of this shaft the poise-bar is made fast by a set screw in a boss to which the poise-bar is secured. Thus when the small intermediate gear is thrust to the one side or the other by the large gears, the poise-bar is correspondingly moved.

It will now be readily understood that as work is transmitted from one pulley to the other through the intermediate gear on the crank-pin, the latter will be thrust to one side with a force proportioned to the effort transmitted, and that the same will tend to tip the poise-bar, to prevent which weights are applied. It is plain that the equilibrating weights on the poise-bar of a duly calibrated instrument, together with speed, etc., furnish data for calculation of the work being transmitted.

The poise-bar is graduated and has a sliding weight, called poise-weight, to move from one end to the other, and the graduations count from 0 at the middle to 10 at either end. At each end of the bar is a knife-edge pin to which is suspended a rod and foot plate, or pan, that may carry 14 or less weights of 5lb. each. Every weight is marked "5lb. = 100 foot-pounds per revolution as shifted from pan to pan."

In starting an experiment, the 14 weights, or less if preferred, may be equally divided between the opposite ends of the poise-bar, and the poise-weight may be in the middle of the poise-bar, when the latter is in equilibrium, or balanced. Now the poise-weight is moved out more and more on the poise-bar till the end is reached if not sooner equipoised by the work being transmitted. Then the poise-weight is brought back to the centre, and one 5lb. weight at the same time moved over from one poise-pan to the other, the same making a difference of 10lb. and just equal to the 10 of the poise-weight moved from end to centre. Then the poise-weight is moved out more and more again till the end figure 10 is again reached, if not sooner equilibrated, when it is again moved back and another 5lb. weight moved over, and so on. Finally, an equilibrium is found as between the poise-bar at one end and the gears at the other end of the crankshaft. Then a count of the weight will tell the number of pounds that acted to turn the poise-bar; the poise-weight being perhaps at 6, and the 5lb. weights perhaps adding up to 30, as if three weights were moved over from one side to the other. It is to be observed that each 5lb. weight moved over counts 10 in the equipoise, as by taking 5 off of one side and putting it on the other making 10 in effect.

The three weights moved over then count 30lb. and the poise-weight counts 6lb., making 36lb. in all. The work being transmitted is therefore 360 foot-pounds per revolution, the number of pounds being multiplied by 10 to give the foot-pounds per revolution.

Another way to count is to keep track of the number of weights moved over, each counting 100 foot-pounds. Then the three weights and the six on the poise-bar make in effect 3·6 weights or 360 foot-pounds per revolution.

The tables are added to illustrate the calibration and the reduction of observations made with the instrument.

Table I. shows that readings from the instrument mentioned are very readily corrected, it simply requiring 5 to be deducted.

The diagram also shows that the various results of observation plot very near to a straight line lying at an angle of 45deg., there being a close agreement between the various observations. Each new instrument should have a correcting diagram of some kind made out for itself, as the law of each instrument may differ from that of another.

TABLE I.—Giving Corrections for Readings taken from the Transmission Dynamometer in use at the Ohio State University.

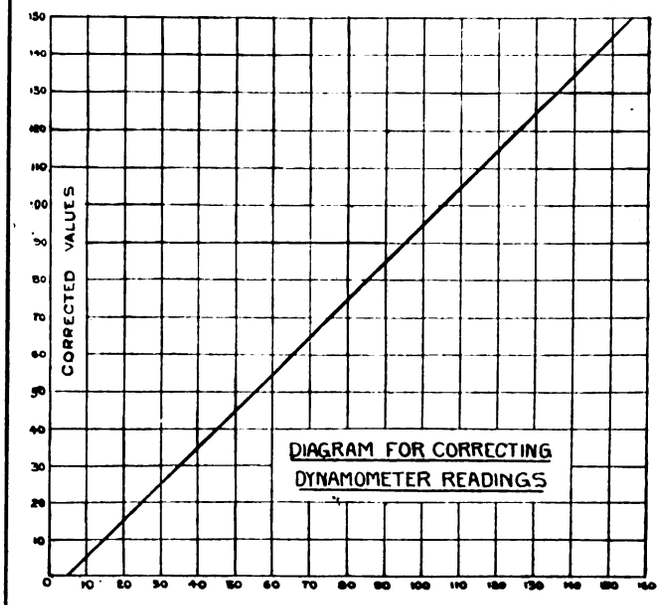

Table II. is an example of results of observations for determining the horse-power required to drive a ventilating fan of about 5ft. diameter.

TABLE II.—Power required to Drive a Ventilating Fan.

Size of fan orifice. ft.	Dynamometer readings.	Corrected dyn. readings ft.-lb. per rev.	Revolutions. per minute.	H.P to run fan.
1	310·0	305·0	336	3·11
2	285·3	280·3	432	3·70
3	259 3	254 3	444	3·40
4	127 6	122 6	328	1·22
4	214·5	209 5	450	2 86
4	224·5	319 5	440	2·93
4	256·0	251·0	460	3 50
4	254·1	248·1	490	3·68

The figures in the column of readings are the means of several readings, and hence the decimals.

The corrected readings are obtained from the Table I. above for correcting the readings of this instrument which gave these results. The Table I. shows that 5 is to be subtracted, simply from each reading, thus explaining the difference between columns 2 and 3. Hence in column 3 we have the foot-pounds per revolution of dynamometer pulley. Before correcting, we have, as readings, the figure 310, which means that three of the 5lb. weights had been passed over from one scale pan to the other, making 300 foot-pounds per revolution, while the poise-bar read 1 or 10 foot-pounds per revolution, making 310 foot-pounds per revolution as uncorrected.

But other instruments may not always give readings, the correction for which will be 5 to subtract, but some figure to be determined by calibration, similarly as was done for Table I.

Among the advantages of this instrument may be mentioned its adaptation for receiving the belts from any direction as down from above, from one side, or up from below. In each case, the most advisable arrangement is to place the cross-tree, on which the pulleys are mounted, in such position that both belts will be tightened by swinging it in one direction, or loosened by swinging in the opposite direction, the belt to take the power force to the machine to be measured being that from the pulley on the longer arm of the cross-tree. Then the belts can be adjusted any time to be just at the desired tightness without relacing, and by simply swing the cross-tree arm.

Formulæ for the dynamometer will be found useful in practice. To this end take

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D = diameter of the belt pulley (driven pulley);
R = radius of gear on that pulley;
r = radius of the intermediate gear and radius of crank arm;
l = half length of poise-bar;
W = difference of weights on scale pans;
w = poise-weight, "reduced" to scale pan;
F = difference of belt tensions on driven pulley;
T = tangential component of pressure between gear teeth;
f = pressure against crank-pin;
n = number of revolutions of pulley per minute;
S = square feet of belt per horse-power per minute;
u = width of belt on dynamometer pulley;

then $$f = 2\,T = 2\,F\frac{D}{2\,R} = \frac{F\,D}{R};$$

$$f\,r = (W + w)\,l = \frac{F\,D\,r}{R};$$

$$\frac{\pi\,D\,n\,u}{S} = H.P. = \frac{F\,\pi\,D\,n}{33{,}000};$$

or, $$\frac{F}{33{,}000} = \frac{u}{S};$$

and $$(W + w)\,l = \frac{D\,r}{R}\frac{u}{S}.\ 33{,}000.$$

In the 25-h.p. instrument at the Ohio State University Mechanical Testing Laboratory, D = 14in., R = 5in., $r = 3\frac{1}{16}$in., $l = 23{\cdot}54$in., and $u = 6$in.

Then, taking the highest value of n at 1,000, and solving for S, we have

$$S = \frac{\pi\,D\,n\,u}{H.P.} = \frac{3\frac{1}{7}\cdot 1\frac{4}{2}\,1{,}000\cdot\frac{1}{2}}{25} = 73{\cdot}3,$$

giving 73·3 square feet of belt per minute passing over the pulley when the instrument is working to its highest capacity. This figure is more ample than the 60 determined by J. H. Cooper as a fair value some years ago.

The quantity of weights to accompany the instrument is

$$W + w = \frac{D\,r}{l\,R}\frac{u}{S}\,33{,}000 = 82\text{lb.},$$

as found by substituting and reducing.

Making the weights of 5lb. each and allowing 10lb. for the equivalent of the poise-weight, we find we require a trifle over 14 weights, but propose 14 as the number to go with the instrument.

In this case seven or less may be placed on each pan in starting an experiment, the poise-weight being at the centre. This collection of weights on poise-bar will serve as an efficient inertia damper to check jerky movements of the poise-bar and reduce demands upon the dash-pot.

Then, as above explained, proceed by moving the poise-weight slowly out to the end of the graduation, 10, if not sooner balanced by the power transmitted. Then move the poise-weight back to 0, and move over a 5lb. weight from one pan to the other which amounts to 10 in effect, and equals the effect of the poise-weight just returned to centre; then move the poise-weight out again to 10 if not sooner balanced; then moving it back to 0 and transfer another 5lb. weight from pan to pan, and so proceed till the balance is obtained between power and poise-bar. Then count up the weights moved over, each being counted for 100 foot-pounds per revolution, allowing the same for the poise-weight clear out, as already described in the previous example. If four weights were moved over, they would count 400 foot-pounds per revolution, and if the poise weight were clear out it would count 100, or 500 foot-pounds per revolution in all. Of if the poise-weight were at 3·7 the count would be 437 foot-pounds per revolution, etc. If running at 100 revolutions per minute, the horse-power transmitted would be

$$\frac{43{,}700}{33{,}000} = 1{\cdot}324\ \text{h.p.}$$

A THEORY AS TO THE CAUSE OF THE PHENOMENA PRODUCED BY THE RONTGEN RAYS.

BY R. C. SHETTLE, M.D.

Since the discovery of the influence of Röntgen rays in producing shadow pictures upon photographic plates and the subsequent proof that similar results can be obtained by a magnet, whether subjected or not to the influence of a live wire, quite a new importance, as it seems to me, attaches to that medium which pervades all matter and space, and which is known as ether.

Vacuum tubes are an artificial mode of producing locally and to a limited extent conditions similar to those which naturally exist between the sun and the earth; because, if lines are supposed to be drawn from the extreme confines of one of these bodies to those of the other, those lines would enclose a columnar space occupied by the so-called ether, through which the bodies in question mutually exercise the stress of gravity, variations of the magnetic needle, so intimately associated with disturbances of the solar photosphere, the phenomena of light, etc., whilst the phenomena produced by the Röntgen rays are for the most part the product of discharges of electric force through the vacuum tube.

The present state of our knowledge of the ether, and of its relations to masses of formed matter, does not appear to give any clue to a satisfactory explanation of the above-mentioned natural phenomena, or of the Röntgen rays phenomena; but I venture to think that when consideration is given to the theory which I published in 1894 as to the formation of matter and the nature of the ether all mystery will vanish, not only as to the mode in which gravity was brought into existence, but also as to the real nature of the ether and its relations to the Röntgen phenomena.

To explain this, I would briefly describe the principles involved in my theory of the nature and cause of gravity. I assume: (1) That prior to the formation of matter space was occupied by a dense homogeneous stuff, every portion of which was in absolute contact with adjacent portions, and, therefore, throughout subject to a uniform degree of cohesion. (2) That matter resulted from the segregation of portions of the original stuff, and cohesion having been destroyed around such portions the force would continue to act from all points on the surface towards the centre, causing the segregated portions to condense and assume a spherical form. (3) That each of these portions, in proportion to the quantity of the stuff which it contained, would by action and reaction (or stress) attract other portions which condensation had separated, but with which they were more or less closely associated. We thus perceive the mode in which the force of cohesion, or force of absolute contact, gave origin to the force of gravity, or force acting at a distance. Rotation of the segregated masses would result as a consequence of the stress, and the spherical would give place to the spheroidal form. (4) That variations in the density of the formed matter would result from the quantity of stuff which entered into the composition of each material unit, because the force of cohesion appears to be capable of indefinite extension. (5) That polarity, or a particular description of axial rotation, would also be determined by the quantity of stuff undergoing condensation. (6) That the now existing ether is simply the residue of the original stuff, its increased tenuity having been acquired by the quantity of stuff condensed from a given volume, and the stress which the condensed matter exercises upon it from opposite points. (7) That as each material unit undergoing condensation would act like an exhaust engine upon this residuum, the atomic surfaces would be coated with a film of this unformed homogeneous stuff, the density of which, would, as the density of the matter itself depend upon the quantity of stuff condensed into that particular unit, which stuff, or ether, in accordance with the opinion of Fresnel, should travel with the matter.

Upon the principles embodied in my theory I have thus shown the relations which exist between formed matter and the forces of cohesion and gravity, and also that the space existing between any two masses of matter must be traversed with lines of stress having certain well-defined relations to and connections with the material atoms which create them. It is therefore equally certain that when two masses of matter, such as the sun and the earth, are rotating axially, whilst each is subject to the attraction of the other, incessant change in the direction of any particular line of stress would occur with every change in the density of the chain of atoms throughout the mass causing such stress. It is further suggested that such changes must originate a vibration in the contiguous ether, which vibration is continued through space. These vibrations have a very important bearing upon the production of electric and magnetic force in our earth.

Turning now to the Röntgen or other tubes of a like nature, we recognise (1) that we have to deal with an artificial vacuum more or less complete according to the degree of exhaustion;

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(2) that the now well-known phenomena are produced when electric force passes through the tube—*i.e.*, that images of dense bodies, in proportion to their density, can be transmitted through perfectly opaque bodies and be impressed upon photographic plates.

Unquestionably this electric force is always the result of the association, under certain conditions, of dissimilar electric bodies, and the force is in proportion to dissimilarity plus the quantity of matter so associated. In other words, the electric force or stress is the direct effect of so connecting two dissimilar forms of matter that they mutually act and react or exercise stress upon each other. The primary effect of this stress, in proportion to its extent, is to disturb equilibrium in the surrounding media by causing the axes of contiguous atoms to face in accordance with the polarity of the stress-creating bodies. The secondary effect is locally to divert the ether from its accustomed interatomic channels into those which more readily admit of its flow, channels which have been opened up, so to speak, by the poles of the atoms all facing one way,* with the result of causing the relative currents of ethereal stuff derived from the motion of the earth through its sea of ether to pass between the two bodies, or, for the time being, electric poles. Consequently, the force passing through the Röntgen tubes, owing to the highly attenuated state of the matter therein contained, acts upon and gives a definite polar arrangement to the atoms of all surrounding matter, which polarity is more especially in the direction of the force.

Hence it appears to me that the Röntgen rays are capable of producing images of bodies, by which they have been influenced, even through opaque matter of less density, such as the non-actinic paper or other substance effectually protecting the photographic plate from light.

The images which I have obtained of magnets, and of the paper by which they have been affixed to the back of photographic plates, are now capable of explanation, because the fact is recognised that wherever the magnets are placed their stress (or action and reaction) exists between the artificial magnetic force and the terrestrial magnetic force. In fact, in proportion to the potential of the artificial magnet and the direction which its poles take with regard to the terrestrial magnetic poles, there is local disturbance—*i.e.*, increase or diminution of the force in the natural and artificial magnets—which disturbance, as to superficial extent or area, necessarily corresponds with the superficial area of the magnet or pieces of paper by which the magnet was kept in position, leading to such disturbance. For example, a sensitive photographic plate within a dark shutter, and lying horizontally, is permeated by rays of force passing from the earth to some planet, or to the sun, such plate receives no image. Let a magnet lie outside, whether above or below, and in a perfectly dark room, as used by a photographer, this magnet disturbs the passage of the rays of force. After a short time the plate on development shows the image of the magnet.

Or, let rays of force radiating from a Röntgen tube be similarly interrupted, they too produce an image in whose production I maintain the light, or what we call light, plays no effective part in image production, but is an incidental or extraneous phenomenon necessarily connected with the passage of the electric current between the poles within the tube.

THE UTILISATION OF WATER POWER, ESPECIALLY WITH A SMALL FALL, WITH SOME EXAMPLES OF PLANTS FOR THE GENERATION OF ELECTRICAL ENERGY.†

BY ALPH. STEIGER.

(Concluded from page 607.)

Assuming that the water power available at Brantham Mills were applied for the generation of electric energy, it would, in the first instance, be necessary to obtain a conveniently high speed to drive an electrical generator without much intermediate gearing. A turbine similar to the one actually working could be made for exactly these conditions, running at 30 revolutions per minute, and a pair of bevel wheels put in of such proportions as to give the first motion shaft a speed of 150 revolutions per minute. This speed would be very suitable to drive a dynamo of 40 h.p. by means of a belt or ropes. A higher speed of the turbine than 30 revolutions would, for such a low fall, only be obtainable at the expense of efficiency. As in this special case the fall, and consequently the power, varies with the rise and fall of the tide, the full power of the turbine can, of course, only be relied on during 15 or 16 hours every day. The power produced during the time when the fall is diminished beyond the limit at which it is 40 h.p., and at less than the normal speed, could probably be applied to charge electrical accumulators. The construction of the turbine shaft deserves some notice. The space underneath the turbine being always filled with

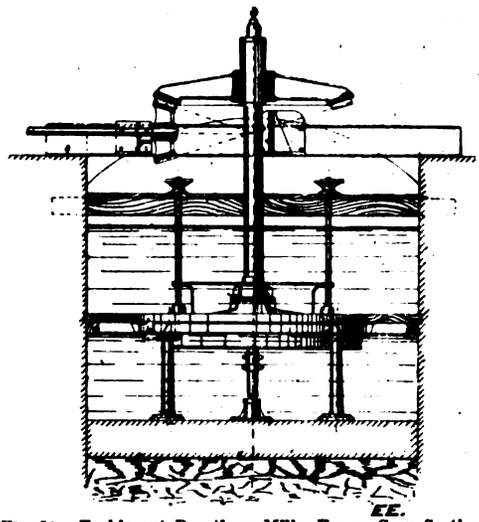

FIG. 5A.—Turbine at Brantham Mills, Essex—Cross-Section.

water, and, therefore, inaccessible, the pan for the footstep is placed on top of a column round which the hollow cast-iron shaft revolves. The upper part of the turbine shaft is widened, and contains an adjustable steel pin which revolves in the pan or cup, filled with oil. Although a well-constructed footstep

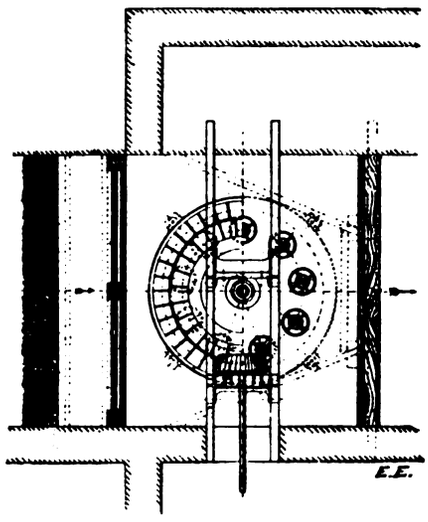

FIG. 5B.—Turbine at Brantham Mills, Essex—Ground Plan.

will last for years without requiring repairs, an easy access to it is of great advantage. Similar turbines were erected by me in other mills near Norwich, Reading, and Lewes. In all cases the fall varies between (23in.) 2ft. 6in. and 6ft., the reduction of the fall being caused by floods, while the water supply varies

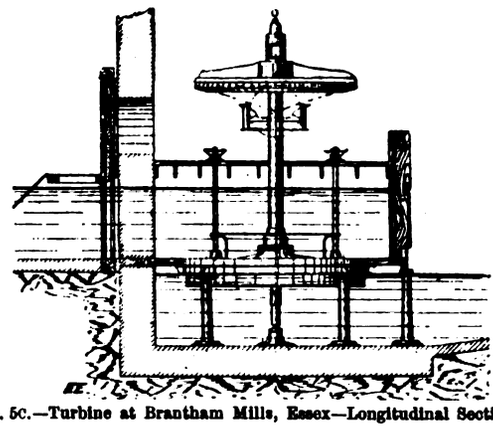

FIG. 5C.—Turbine at Brantham Mills, Essex—Longitudinal Section.

in the proportion of about 1 to 4. In each case the local conditions were carefully investigated and the turbine constructed accordingly. The good results obtained in each case are due to the careful adaptation of the turbine to the conditions. The importance of a careful consideration of local conditions is evidenced by several failures which were recently brought under

* The analogue of this is found in the behaviour of soft iron when subjected to the influence of currents of electricity circulating around it.

† Paper read before the Institution of Electrical Engineers, May 28.

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my notice. In one of these instances, the turbine—which in itself is a very good motor—gives very poor results owing to the disregard of the actual conditions of the locality. Even the construction of some details of a turbine depends sometimes on these conditions, and in several cases now under consideration I have had to depart from the general practice of designs of turbines, in order to secure the highest results when most required. How varied the construction of a Jonval turbine may be will be shown by the following examples.

The turbines of the Geneva Waterworks, built by Messrs. Escher, Wyss, and Co., of Zurich, work under a maximum fall of 12ft. during the winter season, when the water supply is shortest, while during the summer season the water supply stored up in the mountains, in the shape of snow and ice, is abundant. The large summer supply reduces the fall, however, to 5ft. 7in. The power of each turbine, of which there are now 17 at work, is 210 actual horse-power, and they run at a uniform speed of 36 revolutions per minute, whether the fall is 5ft. 7in. or 12ft. The cost in this case was a secondary question, the turbines have, therefore, been provided with the best possible arrangements to suit the large variations of the fall and quantity of water. The drawing shows three concentric rows of buckets. The outer row alone will develop 210 h.p. under the maximum fall of 12ft.—its outside diameter is 14ft. Each of the two inner rows of buckets is provided with a revolving gate, working separately. Each turbine drives a pair of double-acting plunger pumps direct, the crank common to both pumps being fixed on the vertical turbine shaft.

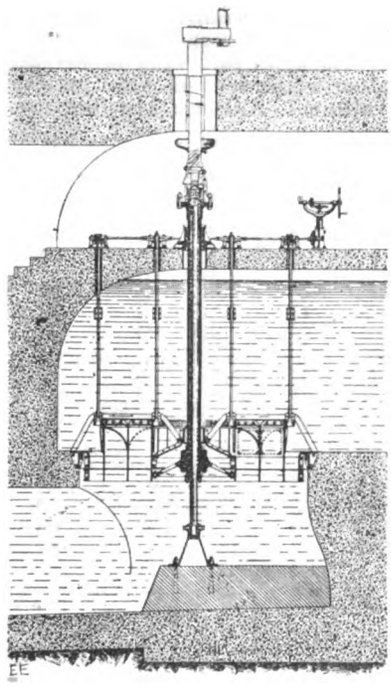

FIG. 6.—Turbines of the Waterworks, Geneva.

An interesting turbine installation, under a fall varying from 10ft. 9in. to 8ft. 10in., in connection with electrical generators, is that at Baden, in Switzerland. It was described in *Engineering* of November 1, 1895. This plant was erected to supply the town of Baden with electric light and the necessary driving power to the new works of Messrs. Brown, Boveri, and Co., the well-known electrical engineering firm. The fall had to be created by a weir and a canal about 2,500ft. long, which added considerably to the cost of the plant. Each of the three turbines is of the Jonval type, giving off 200 b.h.p. It is impossible to build a turbine of that power for the fall available in this case which would run with a speed high enough to drive a generator direct. The turbines run at 40 revolutions per minute, which speed is maintained under the varying fall by means of gates for the inner row of buckets. The generators—two-phase dynamos of the horizontal type, made by Messrs. Brown, Boveri, and Co.—run at 200 revolutions per minute, and are driven direct off the turbine shaft by means of a pair of bevel wheels. The exciter dynamos, of which there are three, of 10 h.p. each, are driven each by a separate turbine. These small-power turbines naturally run at a higher speed—namely, 180 revolutions per minute—and drive, therefore, the exciter dynamos without any intermediate gearing. In most cases in this country where a good water supply is available, the fall will be rather lower than 10ft. or 12ft.; it will therefore require intermediate gearing to drive a high-power generator, and it will even not often be possible to connect it direct with the first main shaft driven off the turbine by bevel wheels. Belt drives are very convenient to get up the necessary speed of dynamos, but for large power they are very expensive, and absorb a considerable amount of the power in friction. The ordinary round hemp and cotton rope is objectionable, on account of requiring frequent repairs and resplicing. During an inspecting tour in Switzerland last summer, I came across a new kind of hemp rope, which seems to supply just what is wanted to drive large-power dynamos. A piece of this patent rope is here for inspection. It is a plaited rope of extreme pliability, which does not stretch. I found this rope working at the generating station at Schaffhausen. The power at the generating station is transmitted from the countershafts, driven off two turbines of 300 h.p. each by means of bevel wheels, on to the generators by means of 10 such ropes, 1¾in. thick. The rope pulleys on the dynamos have a diameter of 5ft., running 300 revolutions per minute. The rope pulleys on the countershaft have a diameter of 13ft. 6in., and the distance between the centres of shafts is 51ft. The power is electrically transmitted to a spinning mill about half a mile distant from the generating station. The secondary station consists of an electromotor of 200 h.p. coupled directly to a main line shaft, and two electromotors of 190 h.p. each coupled together. The latter, running at 300 revolutions per minute, carry a rope pulley of 5ft. diameter with 14 grooves. One hundred horse-power are transmitted by four such ropes to a shaft 21ft. above the electromotor at an angle of 51deg., while the remaining 250 h.p. are transmitted to another shaft on about the same level and 17ft. 8in. distant, running with 130 revolutions per minute. In spite of the unfavourable relative position of the shafts, these ropes work with extreme regularity and easiness, and their adaptation has, according to the manager of the spinning mill, put an end to the trouble and frequent stoppages caused by the breaking of the round ropes which were previously used.

Returning to the description of water-power plants proper, two more examples in connection with the generation of electricity deserve to be mentioned, showing how certain objects can be attained by a special construction. One of these is the installation of five new turbines for the aluminium works at Neuhausen, on the Rhine Fall, in Switzerland. One of these turbines is here illustrated. Each of these turbines gives off 610 b.h.p. under a fall of 66ft., with a quantity of water of 6,500 cubic feet per minute. With the high fall, a high speed suitable for driving the dynamo direct is naturally obtained—

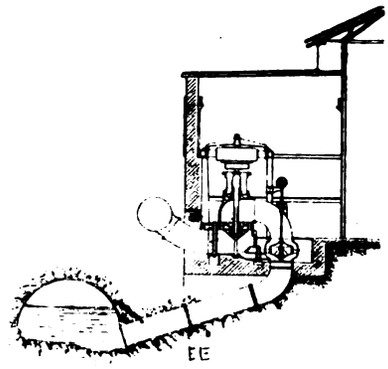

FIG. 7.—Turbines of the Aluminium Works at Neuhausen, Switzerland.

an arrangement which has also been adopted in this case to economise space. On the other hand, the load on the footstep of a turbine of the power mentioned by the pressure of the water, in addition to the weight of the armature of a generator of corresponding dimensions, is so great that a special arrangement had to be adopted to release the footstep of at least a part of that load. In order to overcome this difficulty, the turbine has been reversed, the water passing through the turbine upwards, acting, therefore, in the opposite direction to the weight of the machinery. The boss of the turbine wheel is, moreover, formed into a piston, working in a cylinder, to which water under the pressure corresponding to the fall is admitted, thus counteracting again the weight of the moving parts of the turbine and dynamo. The water, after passing through the turbine, is conducted to the tail-race through a suction tube, the turbine being placed 15ft. 9in. above the tail water. It runs at 150 revolutions per minute, and is a single Jonval turbine. To regulate its speed, if required, a ring gate is inserted in the suction tube, while it can be stopped by a throttle-valve in the wrought-iron tube taking the water to the turbine. The total power now utilised by these aluminium works is 4,550 h.p. The turbines were constructed by Messrs. Escher, Wyss, and Co., of Zurich, and the dynamos by the well-known electrical works at Oerlikon. Each dynamo is of 7,500 amperes and 55 volts.

The last turbine installation here illustrated is that at Zufikon-Bremgarten, also in Switzerland. The drawing shows another arrangement to counteract the weight carried by the footstep, and at the same time an arrangement by means of which the necessary speed to drive a dynamo of large power

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direct under a medium fall is obtained. The plant consists of four sets of double Jonval turbines of 325 b.h.p. each, running at 115 revolutions per minute, and a smaller Jonval turbine of 34 b.h.p., driving two exciter dynamos, running with 210 revolutions per minute, and was erected to supply electric light to the neighbouring town of Wohlen, and driving power to the new works of Messrs. Escher, Wyss, and Co., in Zurich, and a large flour mill close by these works. The distance over which this power is transmitted is about 11 miles. The fall is 17ft. 6in., and was obtained by building a dam across the River Reuss, and a tunnel about 1,100ft. long across a hill round which the river flows at a rather high speed. The water is divided between two Jonval turbines fixed on one common shaft so that it passes upward through the lower wheel and downwards through the upper wheel. By distributing the water in this manner, the diameter of each turbine is reduced, and the speed consequently increased. At the same time the pressure of the water, which would otherwise act on the footstep, is entirely counterbalanced. The central part of the lower wheel is, moreover, formed into a disc, on which the water presses from below, releasing the footstep also partly by the weight of the revolving parts of the turbine and the dynamo. The space between the two turbines on each shaft is connected with the tail-race by a flume formed of concrete, which acts as a suction tube. This turbine plant was also erected by Messrs. Escher, Wyss, and Co., and the dynamos were built by the Oerlikon Works.

The examples given above of the utilisation of water power may be considered as representative types of successful installations under different conditions. They are sufficient in number and in variety to prove the necessity of a selection from motors which are different in principle, and of the careful adaptation of the turbine selected to the local conditions and requirements. A turbine installation under a low fall will be more costly than one under a higher fall; it is consequently of special importance to obtain the highest possible efficiency, even at an extra expense, under a low fall. The cost of the turbine itself

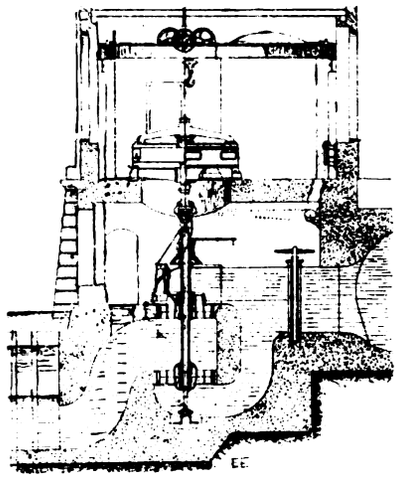

FIG. 8.—Turbines at Zufikon-Bremgarten, Switzerland.

is only a fraction of the total outlay for the plant, including foundations, connection with the machinery to be driven, and sometimes a weir and a canal. The cost of these permanent structures exceeds that of the motor; it is therefore a penny wise and pound foolish policy, after putting in the permanent structure, to try and cut expenses by putting in a turbine of insufficient capacity or inferior efficiency. The commercial value of a water power depends rather more on the annual outlay on the same than on the first cost, and the annual outlay for the work obtained from the power is the smaller the higher the efficiency of the plant. The efficiency of a turbine which can be obtained and honestly guaranteed, even if the fall is low, is about 75 per cent. Eighty per cent. and a little over is sometimes obtained under favourable conditions, and has been proved by careful tests made by responsible experts; but an efficiency of 85 and 90 per cent., sometimes claimed, is never reached if the quantity of water be accurately measured during the test. If the efficiency of the turbine is guaranteed at all, it should be stated not only for the most favourable conditions but also for a reasonable minimum of the fall or the quantity of water.

In many instances within my own knowledge, water power, in itself sufficient to drive the machinery of a factory, but improperly utilised, is supplemented by artificial power, produced by steam, gas, or oil engines. The loss of money caused by the waste of the cheap power from a running stream in this manner amounts certainly to a big sum in this country alone. The annual cost of such auxiliary power, calculated for 3,000 working hours, may be put at three to four times the cost of water power, and calculated for 6,000 working hours, four to eight times the cost of water power. A judicious utilisation of the water power in such cases would not only result in an enormous saving of money, but in a gain of a large amount of power now unutilised. Most factories are closed at night time, when the water is allowed to run away without being made use of. Assuming that the water power is insufficient to drive all the machinery in the daytime, while it is wasted during the night, electrical storage batteries in connection with a generator might very advantageously, and perhaps with greater economy, be used instead of auxiliary steam, gas, or oil engines. It seems probable that in the near future the electrical transmission of power will take the place of shafting and belt drives in factories, when certainly the waste of water power would be prevented in the manner suggested. Owners of factories driven by water power might even find that by improving their water power they obtain spare power which could be profitably applied by the generation and distribution of electrical energy in the immediate neighbourhood.

I may add that the majority of large-power central stations now being erected in Switzerland for the generation and distribution of electrical energy are mostly utilising small or medium falls varying between 10ft. to 30ft. The storage of water in the shape of snow and ice on our mountains provides us with a good water supply during the summer, but the low temperature in winter reduces that water supply very considerably. The water power there is just as variable as in other countries, and those falls which can be advantageously utilised on account of being situated in the inhabited and industrial districts are often not any higher, or not much higher, than in this country; the only difference being that such small falls occur more frequently, rendering a concentration of large power in one place easier, and perhaps less costly. Still, it is my conviction that concentration of water power for the distribution of electrical energy, or for the generation of a large amount of electric current, as required for electro-chemical and electro-metallurgical processes, is possible in many places in this country without going into prohibitive expenditure for canals, etc.

In conclusion, I hope to have succeeded in my endeavour to show how water power under low falls can be, and is, very advantageously and economically utilised for the generation of electrical energy, and that a very large amount of water power is now running to waste which could, in conjunction with electrical machinery and apparatus, be turned to profitable account by such a hearty co-operation of the electrical and the water-power engineer as has resulted in such success of commercial enterprise in my native country.

DISCUSSION.

Mr. Tremlett Carter opened the discussion. Mr. Steiger had promised to prove the utility of small falls, and he (Mr. Carter) failed to appreciate the logic of introducing examples of large falls of 300ft. or 350ft. The only really small fall described was the Brantham one, where they had a turbine running at 24 revolutions a minute. That would not be at all suitable for driving a dynamo. England was admittedly a country of small falls, and those of a character which were liable to suffer from two very bad complaints—namely, too much water and too little water. He had in his mind a mill site he had seen, which under ordinary circumstances looked a highly desirable one, but with only a little extra rain the mill race—in fact, everything was completely under water. Moreover, in most English rivers the millers were in possession, and pounded up the river when they were not working, so that it was impossible to get a regular flow. He was familiar with a little electrical generating station driven by a water-wheel, with stand-by engines, which had to run charging accumulators in the daytime for the night load, because at night a miller just above shut back all the water, so that there was no river at all when it was most wanted. Another objection to a low fall was the quantity of water to be dealt with, and the difficulty of governing when there was such a mass of water to be dealt with. It was wrong to say, as had been done, that such and such a type of turbine was adopted because the dynamo required to be run at a certain speed. Dynamos could be built to suit the best speed for the turbine. The partial admission system amounted to having several turbines, of which only one might be at work. He thought reaction turbines were to be preferred unless the fall was exceptionally high, as in the Comstock lode. Water power might be the free gift of Nature, but there seemed to be frequently a legacy duty of 100 per cent. to be paid in order to get it.

Mr. Alexander Siemens remarked that the case of Brantham required careful consideration because it was necessary to eliminate the complication introduced by the periods of high water, which occurred at a different time every day. The possibility of using water power in connection with electric machinery had not been passed over in this country. Nearly 20 years ago—he could not at that moment remember the exact date, but it was before the invention of the incandescent lamp—Lord Armstrong had used water power for the electric lighting of his picture gallery. Then there was the case of Godalming. In 1881 the streets of that town were lighted electrically by water power from a mill with a low fall. Godalming was the first town in the world to light its streets by electricity in this way. Unfortunately, the thing was before its time, and was not a financial success. He agreed with Mr. Carter that in England it was impossible to rely upon your water supply.

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Therefore, it was necessary to have a stand-by plant. The double expense destroyed the economy, and it was better not to complicate the plant by the addition of the water power.

Mr. Shoolbred, as an example of the utilisation of water power by turbines, referred to the case of Menier's chocolate works. The fall varied from 5ft. 6in. to 15in., and the whole of the River Marne had to be dealt with. He thought the impulse turbine should not be put on one side entirely. Most of Mr. Steiger's examples had been confined to turbines of the Jonval type. He would remind them that there was a well-known reaction turbine in this country—the "Thomson" inward-flow—the inventor being the late Prof. James Thomson, the brother of Lord Kelvin.

Mr. M. Mowat gave some particulars of a large turbine plant used by his firm for driving two cotton mills in India. It was probably the largest water-power plant in the Queen's dominions. They had at present eight turbines of 250 h.p., and hoped ultimately to work up to 4,000 h.p. By using water power they were able to give the proprietors a better return than they otherwise would if they had to burn coal. Power was transmitted from the turbines to the mill—an eighth of a mile—by means of wire rope, which worked admirably. The waterfall utilised is at Gokak, on the Ghataburba river, Southern Mahratta country, India.

The **President** said that as Mr. Steiger had to reply, and the meeting could not be adjourned, any further observations must be handed in in writing to the secretary.

[Among the observations handed in were some from **Mr. W. Geipel**, who remarked that Mr. Steiger recognised the difficulties in utilising low falls due to variations in head and quantity—in the one extreme there was all head and little water, while after heavy rain there was abundance of water and little head; and between these two limits all degrees depending upon the proverbially variable British weather. Mr. Steiger proposed to meet these difficulties by subdividing the turbine into several compartments. It might be that in some cases this was a good arrangement; but from his experience in the use of water power for electric lighting purposes, he found that the varying load on the dynamo must be considered in addition to the difficulties of the varying water power. It was also to be remembered that a turbine had a critical speed at which the best efficiency was obtained, and that this critical speed varied with the head of water; whereas, on the other hand, the dynamo required one constant speed. It was frequently preferable therefore to subdivide the water power and use several turbines, each driving its own dynamo. These turbines should be arranged for working at different heads—one should be for the maximum head and of suitable size to use only the minimum quantity of water available under that condition, the second should be suitable for a less head and larger quantity of water, and so on. The number of these units would of course be governed by the conditions. An additional advantage of the method is that repairs may be effected to one unit whilst others maintain the supply. This system might not be economical in all cases, especially where the maximum available power is small, but in many cases it would give a very much better all round efficiency than the compound turbines referred to by Mr. Steiger. There was a more important point only briefly referred to by the author which was not dealt with by any of the speakers, and that was the question of first cost. Mr. Steiger said, "The commercial value of a water power depends more on the annual outlay than on the first cost." On this point he (Mr. Geipel) was directly at variance with the author, as he had always thought that the annual outlay on turbines was almost negligible, and that the only other consideration was first cost. If that item was also negligible, why then the millennium of those gentlemen who regularly promote in the public press the utilisation of the tides was indeed at hand. It was unfortunately this very question of excessive first cost which made the power produced by the low waterfalls derivable from tides so much more expensive than that from steam or other engines. The importance of first cost was being daily driven more closely home to the minds of all electrical engineers, and for that reason it was to be regretted that the paper contained no information whatever upon this important point. The use of storage batteries for storing the power during periods when the power is not required was well known, but he (Mr. Geipel) had in several cases found it cheaper to construct a water reservoir to effect the same purpose. With regard to the difficulty experienced by the author with round ropes, Mr. Geipel thought he must have got hold of a very bad quality of round rope. With good English-made round ropes there would be no hesitation in transmitting more than double the power stated.]

Mr. Steiger, in replying, said he must contradict the statement of Mr. Carter that impulse turbines were only suitable for very high falls, say 1,000ft. The impulse turbine was suitable for any fall, from 3ft. upwards, where the fall was constant, and they had the advantage of being able to be regulated according to the quantity of water without loss of efficiency. If the law permitted a miller in shutting off the water in the way described—well, in every country in which water power was appreciated it did not, but prevented the water being shut off from the user below when the user above happened not to be using it. Automatic governing with very low falls was not more difficult than with very high ones. In the latter case the difficulty was that a trifling movement produced a large difference in the power. As a matter of fact, with reference to the question whether the turbine or the dynamo should determine the speed when it was desired to use large dynamos directly coupled to the shaft, the turbine maker was often asked by the dynamo builder for a particular speed and endeavoured to supply it. It was not a fault of water power if people expected too much of it, or when the minimum water supply corresponded to 100 h.p. they put in a dynamo plant that wanted 150 h.p. He would remind Mr. Shoolbred that he had pointed out in his paper that it was the variation of water-level to which most low falls were liable that determined the type of turbine. A reaction turbine would be preferable for working a dynamo under a low fall, because of its higher speed, especially if the tailwater level varied. With reference to Prof. Thomson's vortex wheel he believed it was efficient enough at full gate, but he did not know what the efficiency was at part gate. It was a pity that more practical tests had not been made with various types of turbines, for some for which high results were claimed had proved in practice very disappointing. The efficiency under various conditions should be stipulated for.

Major-General Webber proposed the vote of thanks to Mr. Steiger for his paper. Without using the opportunity to get in a speech on the subject, he wished to disagree with the attitude of Mr. Carter on the subject. Mr. Steiger's paper could not be a full exposition of the subject, but was eminently suggestive, and would induce many of them to go into the question of water power. So far as his experience went, he might say that he had inspected many water powers with low falls in various parts of the country, and he believed that there were many instances in which it was worth while to investigate its use.

Prof. Silvanus Thompson seconded the vote of thanks, and remarked, with reference to what Mr. Shoolbred had said about the turbines at the Menier works, on account of the diminution of the fall in times of flood it had been necessary to put in an undershot waterwheel to meet such occasions.

The list of candidates balloted for and elected at the commencement of the meeting was given, as usual, in our last week's issue. This being the last meeting of the session, the list which was passed for the next ballot (which in the ordinary course would have been taken in a fortnight) had to be dealt with before the adjournment. The following therefore were balloted for and elected at the close of the meeting: Dr. Alvaro de Vilhena, vice-director of the Brazilian Government telegraphic department (foreign member); A. H. Howard, 39, Victoria-street, S.W. (member); E. J. Cruiser, 73, Merrion-square, Dublin; J. Gray, University, Glasgow; T. Rungay, Blenheim Palace, Woodstock; G. E. Piggot, 110, Cannon-street; and Sidney Weiss, Harbour-road, Edgbaston (associates); and W. Steuart, 1, Girdler-road, Kensington (student).

MUNICIPALISATION OF TRAMWAYS.

For more than a year a special committee of the Manchester City Council have been considering the subject of the tramways of the city and the desirableness of putting them entirely under municipal control. The committee have now issued their report, in which they give information as to the cost, results, and manner of working tramways by the Corporations of Glasgow, Blackpool, Plymouth, Leeds, and Huddersfield, and of which the *Birmingham Daily Post* published the following abstract:

In Glasgow, on August 1, 1895, the result of the first 11 months' working of the tramways as a Corporation department, showed that the gross revenue had been £226,414. 3s. 4d., and the gross expenditure £202,209. 9s. 2d. This left a credit balance of £24,204. 14s. 2d., from which the sum of £9,193. 19s. 7d. had been written off capital account as depreciation, £6,750. 9s. 1d. had been placed to reserve fund for renewal of permanent way, and £8,260. 5s. 6d. had been paid to the common good. This payment to the common good—fixed by the Town Council at the rate of £9,000 per annum—was in lieu of the former net revenue of the common good from the tramways, the exact average annual amount of which during the 23 years of the lease was £2,766. 8s. 9d. In Huddersfield there had, from 1882 up to last year, been an annual deficiency, amounting in all to £41,238, which had had to be provided for out of the rates. The Leeds Corporation had acquired the tramways in that city too recently to give valuable information; at Plymouth there had been a loss, but the growth of income and diminution of expenditure were gradually tending to bring the undertaking up to paying point, whilst at Blackpool there was a record of profit. The committee go on to say: "The principal arguments in favour of the 'municipalisation' of the tramways appear to be as follows: (*a*) The tramway system is a public necessity and a monopoly, and, as such, should not be used to put large dividends into the pockets of shareholders. (*b*) The tramway service might be worked better from a citizen's point of view as opposed to the point of view of shareholders—for instance, 'through routes' might be arranged for, the present lessees having always opposed the adoption of 'through routes.' (*c*) The dividends now paid to the shareholders would be paid into the public purse. (*d*) The policy hitherto adopted by the Manchester Corporation has been in the direction of working and entirely controlling all undertakings of a municipal character—*e.g.*, gas, water, electric light, and hydraulic power. The principal arguments against the 'municipalisation' of the tramways appear to be as follows—viz.: (*a*) If the general tramway system of the district were 'municipalised' in either of the two ways already mentioned, the responsibility attaching to Manchester would be very great. We should have a municipality or municipalities working a tramway system much greater in dimensions than any other tramway under

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taking in the country, and the information as to what has been done in other towns does not furnish encouragement for the Corporation in this direction. (*b*) Various difficulties in the way of 'municipalisation' of the general tramway system of the district present themselves, by reason of the expiration of the various leases and the power of the various local authorities to purchase the tramways owned by the Manchester Carriage and Tramways Company within their respective districts not being synchronous. (*c*) The ramification of the tramway system into districts outside the city boundary, and the fact that many of the lines are not owned by the local authorities places Manchester in a more difficult position than Glasgow was in. In Glasgow the tramway system is entirely contained, with two slight exceptions, within the city boundary, and the whole system (including the exceptions referred to) was constructed and is owned by the Corporation. (*d*) The tramcar service which has been provided by the lessees of the lines in Manchester has been an excellent one from almost every point of view. The tramcars themselves will bear favourable comparison as regards comfort, cleanliness, and general appearance with those of any other city in the kingdom. The lessees have met the requirements of the community by the adoption of penny stages on all the routes. (*e*) From a financial point of view the lease of the lines has been satisfactory. The Corporation accounts at March 31, 1895, show that the rents received from the lessees have enabled the Corporation to pay off practically all the loans, to pay for all ordinary repairs of the lines, and for the renewal of a number of them, and to pay a total sum of £70,911. 12s. 9d. to the city fund in aid of the rates. (*f*) At the close of the 23 years during which the Glasgow lines were leased to the Glasgow Tramways Company, the financial statement of that Corporation shows that the total amount of net revenue paid to the 'common good' was £63,628. 1s. 1d., and there was still a loan debt owing of £143,495. 16s. 11d. During the period which the Manchester leases have run (say, 15 years) the total amount of net revenue paid to the city fund has been, as stated above, £70,911. 12s. 9d., and the loan debt owing on March 31, 1895, was £16,593 only. (*g*) In the case of Glasgow it was not until after the failure of the negotiations between the Corporation and the lessees of the lines for a renewal of the lease on terms satisfactory to the Corporation that the Town Council decided to work the tramways themselves. The necessity, therefore, of 'municipalising' the tramways in that city may in a measure be considered to have been forced upon the Corporation. If the action of Glasgow is to be a guide to Manchester, it would appear desirable, therefore, for the Corporation in the first instance to approach the present lessees with a view to a renewal of the lease on terms satisfactory to the Corporation, and, in the event of such negotiations failing, then, and not until then, should the question of 'municipalisation' be entertained. (*h*) If it be arranged, as has been suggested, that the leases which expire in 1898 be extended at existing rents so as to be coterminous with the main lease, which expires on April 27, 1901, ample time will then be afforded for the consideration by the Corporation of the various kinds of tramway traction, other than horse traction—*i.e.*, cable, steam, underground and overhead electric traction—and it appears probable from the developments which are now taking place, and the experience which other towns are gaining in regard to mechanical traction, that this Corporation will, when the subject is taken in hand by them, have sufficient evidence to enable them to come to a conclusion in the matter. (*i*) It may also be pointed out that by making the leases coterminous in 1901, ample time will be afforded for forming a more correct judgment than can be made at the present time of the financial results of the working of the tramways in Glasgow and other towns." In conclusion, the committee report that after full consideration of the subject referred to them by the resolution of the City Council, they are of opinion that it is desirable to allow the matter to remain over until nearer the termination of the first lease, which will expire on May 1, 1898, and the Corporation should make application to Parliament for powers themselves to work the tramways of the city. The committee also recommend that this subject be left in the hands of the Paving, Sewering, and Highways Committee, by whom the tramways of the city were constructed, and who have in their possession all necessary information.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MUNICIPAL ELECTRICAL ASSOCIATION.

SIR,—I send herewith advance proof of programme of the first annual meetings of the association, which will be held in London on Wednesday, Thursday, and Friday, the 10th, 11th, and 12th inst, and also enclose card for your representatives.

Copies of the papers are to be sent out in good time before the meetings, at which short abstracts only will be read in order to facilitate the discussions, but in order that the interest of these discussions shall not be prejudiced by premature publications the committee have considered it desirable to copyright the papers in the name of the association.

This has been done, but should you see fit to publish all or any of the papers on any date after the 15th inst. you have full liberty to do so.—Yours, etc.,

WM. L. MADGEN, Hon. Secretary (*p.p.* G. J. S.).

117, Bishopsgate-street, E.C., June 1, 1896.

[The above letter, together with the programme referred to, reached us this week. The honorary secretary of the Municipal Electrical Association in kindly forwarding us the "advance proof" from the office of the contemporary with which he is connected has not acted with his usual business-like promptitude. This "advance proof" was sufficiently advanced to appear complete in our contemporary's columns on May 21. We also notice that publication of the papers in our columns on the 12th inst. would be premature, and would prejudice the discussion on the papers which are read on the 10th and 11th inst. respectively. Why?—ED. *E. E.*]

MUNICIPAL ELECTRICAL ASSOCIATION.

FIRST ANNUAL CONVENTION.

PROGRAMME.

WEDNESDAY, JUNE 10.

General meeting for the discussion of papers.—Royal United Service Institution, Whitehall, S.W. 10.15 a.m.

President's address: "The Municipal Electrical Association and its Objects."

Papers for discussion: (1) "Electricity Supply at 220 Volts," by A. S. Barnard, borough electrical engineer, Hull. (2) "Alternating-Current Stations and High-Voltage Lamps," by Harold W. Couzens, borough electrical engineer, Taunton. N.B.—Paper Nos. 1 and 2 will be taken together for discussion. (3) "The Control by Municipal Authorities of Consuming Devices and the Wiring connecting them to the Mains," by C. H. Wordingham, city electrical engineer, Manchester. (4) "Electricity Works Records," by A. B. Mountain, borough electrical engineer, Huddersfield.

Adjournment. 1 p.m.

Visit of inspection to the works of the London Electric Supply Corporation, Limited, Deptford. Chief engineer, Mr. P. W. D'Alton. 4 p.m.

THURSDAY, JUNE 11.

General meeting for the discussion of papers.—Royal United Service Institution, Whitehall, S.W. 10.15 a.m.

Papers for discussion: (5) "The Cost of Electricity Supply," by Arthur Wright, borough electrical engineer, Brighton. (6) "Cable Specifications and tests," by Joseph A. Jeckell, borough electrical engineer, South Shields. (7) "The Organisation of an Electricity Works Staff," by E. T. Ruthven-Murray, city electrical engineer, Worcester.

Adjournment. 1 p.m.

Reception by the Electric Lighting Committee of the Islington Vestry, Vestry Hall, Upper-street, Islington. 3.30 p.m. (The Vestry Hall is within a few minutes' walk of the Agricultural Hall and of The Angel at Islington. It is best reached from Charing Cross by cab or 'bus. Chairman of the Electric Lighting Committee, Mr. Samuel Lambert)

Discussion on paper: (8) "Combined Electric Lighting and Traction Plants," by John Hesketh (electrical engineer to the Government of Queensland, late borough electrical engineer, Blackpool) and John H. Rider (borough electrical engineer, Plymouth).

Visit of inspection to the Islington Electricity Works, Edengrove. 5 p.m. (Within a few minutes' walk of the Vestry Hall.)

FRIDAY, JUNE 12.

General meeting, for members and associates only.—Royal United Service Institution, Whitehall, S.W. 10.15 a.m. Election of president, vice-presidents, three members of committee, officers, and place of meeting for the convention of 1897. General business.

Adjournment. 12 noon.

Visit to Brighton by the 1.50 from Victoria or 2.0 from London Bridge, arriving at Brighton at 3.15 and 3 20 respectively.

Reception by the Electric Lighting Committee of the Corporation of Brighton at the Royal Pavilion. 4 p.m. Mayor of Brighton, Alderman Blaker. Chairman of the Electric Lighting Committee, Alderman Stafford.

Discussion on paper: (9) "Extensions to Outlying Districts," by A. H. Gibbings, borough electrical engineer, Bradford.

Visit of inspection to the Brighton Electricity Works, North-road, near the Pavilion. 5 p.m.

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STATISTICS.

A Fellow of the Statistical Society would probably argue that you could not possibly have a surfeit of statistics. A doubt expressed as to their universal value would be met with the statement that the statistics were all right, but that the interpretation of the statistics might be wrong. Those who are familiar with the processes of interpretation can usually approximate to a fair conclusion; but we ask in all humility, are the men who are pestered week by week with electrical statistics competent to form a correct conclusion from the mass of undigested figures put before them? Again and yet again we have been told that consultants of these figures have from them formed opinions difficult to eradicate and unutterably bad. The ever-varying conditions which determine the results are not and cannot be given, and without these a right interpretation is hopeless. Further, although such statistics may be pronounced valuable in certain instances, they are not restricted to the sight of the people who can use them profitably, but are more often used to influence the votes of men who are not familiar with all the conditions. We contend, then, that the indiscriminate use of statistics is as opposed to the true interests of the industry as is the indiscriminate use of the results of experiments with refuse destructors. Many a man has been led into error by statements that so many pounds of steam had been, and could be, obtained by the burning of refuse. In this particular direction we ought to specially caution some young and enterprising electrical engineers who are either ignorant of the ordinary conditions of refuse destruction or who wilfully suppress part of the truth, allowing their clients to make wrong inferences. Most professional men have cause to know that many of their troubles arise through indiscretions of professional brethren. Mr. Smith is unable to judge between Jones and Robinson. He has, perhaps, consulted Jones professionally, while Robinson offers gratuitous advice. Such advice is often backed up by a host of figures put forward without explanation of peculiar conditions, and, in fact, out of pure cussedness and a desire to put a spoke into a professional brother's wheel. Another system of half truths arises in the case of generation of steam by ordinary methods. Conflicting figures are shown as to cost in somewhat similar places, but nothing is said probably about local by-laws which may prohibit the use of a particular kind of coal in one place but not in the other. Suppose, for example, the restriction is to permit the use of Welsh steam coal only in one locality, while other kinds of coal are permissible in the other locality. This one condition may be the cause of the differences in the statistical figures. We have cases where the result was far different to the estimates—in fact, it usually is with those gentlemen who think more of getting in and getting their commission than of making a reputation. "You did not tell me this," says the employer; "You did not ask me," says the engineer. An answer of that kind at once stamps the man as an incompetent adviser. The employer does not engage him to suppress

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material facts, but to tell the whole truth, and nothing but the truth. Sometimes complainers will ask us to name these men, and thus make a black-list. They would not mind us having the trouble and expense of litigation, though usually the request is accompanied by a postscript—"Please keep my name out of it." Others say more plainly, "We should like to see all this stopped, but we will have no hand in it; for were we to show in the matter, orders which we now get from these men would be lost to us." Candidly, is there not at the present moment far too much of this tampering with and pandering to the unstable policy of getting work at any price? There is hardly a phase of electrical engineering wherein these simple statistics have not played a wrong part. It matters little whether we deal with lighting or transmission of power or with chemical matters. The ordinary man cannot deal properly with figures, and when the ordinary man is a capitalist who is asked to embark money in an enterprise the success of which is based upon statistics, he is in a worse plight than ever. The success of electric tramways at a score of other places is no proof of their success at Little Pedlington. Similarly, the success of a particular system of electric lighting at a dozen places is no proof that that is the system for the thirteenth place. If those who use statistics would deal only with averages, there would be some reason to pay more attention to the figures; but when they deal so much with the particular, it becomes increasingly necessary to wage active war against their operations. According to the theories of certain young engineers, their work consists only in devising schemes for one or two places and duplicating one or the other of those schemes at every place they are asked to advise. The plan is very attractive, it costs little in brains or drawings, the figures are forthcoming at a moment's notice, but unfortunately the result is not always satisfactory. Said one individual: "What do I care about the future? I am full of work at the present, and making a good income, so the future must take care of itself." The careless use of statistics, with a minimum of explanatory information in lieu of real work, tends to the consideration of to-day and forgetfulness of to-morrow. The method is daily being exaggerated, and we understand that the practice of the future will be for the engineer consulted to give the consultant copies of the standard books on the subject instead of a report of some three hundred pages, backed with voluminous specifications describing one maker's specialities.

RESULTS ACCOMPLISHED IN DISTRIBUTION OF LIGHT AND POWER BY ALTERNATING CURRENTS.*

BY W. L. R. EMMET.

The introduction of successful polyphase motors has constituted a very radical and important step in the development of the electrical art. The number of persons who realise the importance of this step is as yet small, and, like other new things, it cannot attain great successes until its merits and possibilities become more or less familiar to the public and to the practical business men on whom the responsibilities for new developments must largely rest.

In the past the use of alternating currents has been almost exclusively for incandescent lighting, and this narrow limitation has crippled the development of the art. While the applications of direct currents have called forth very large investments in plants and distributing systems, the uses of the alternating currents have, as a rule, been on a much smaller scale, and the methods used have been developed rather with a view to reduction in first cost than to the attainment of the most economical results in operation.

The reasons for this somewhat half-hearted development may be stated as follows: (1) the average efficiencies attained in most alternating plants have been very low; (2) the distribution of potential obtainable with the ordinary methods has been imperfect; (3) no reliable alternating arc lamps have been available; (4) no practicable form of single-phase alternating-current motor has, up to the present time, been introduced.

At no time have all these difficulties been entirely unavoidable in alternating-current distribution; they have, however, been fixed fixtures of the system as it has in the past been installed by our manufacturing companies and used by electric light companies in this country, the state of the art being such that improvements were beyond the reach of most central-station managers. In recent years great developments have been in progress in the branches of electrical science pertaining to alternating currents. Much new apparatus has been developed, plants have been installed on new lines, and practical results are to-day being accomplished that show that it is possible to overcome all of the objections which have been mentioned. We will briefly review in order some of the means by which the difficulties mentioned have been and can be avoided.

Efficiency.—The greatest losses in the average alternating plant are due to the waste in iron cores of transformers, which goes on whether the transformers are loaded or not. This waste can be reduced either by the use of transformers of high light-load efficiency or by arrangements for cutting out transformers at light load. Where primary distribution is used with large numbers of independent transformers, the extent to which these remedies can be adopted is very limited, since reduction of core loss can be obtained only at the expense either of regulation or of first cost. If, however, secondary distribution is used—that is, low-tension mains with transformer sub-stations—it is often possible to arrange means of cutting out transformers at times of light loads. Furthermore, on such systems very accurate regulation in transformers is a matter of no importance, since all transformers divide the load more or less evenly between them instead of operating from the same line at various conditions of load as in primary distribution. Thus, for this secondary work, we can build special transformers having very small core losses and thus obtain very high all-day efficiency without impairment of regulation.

I have in mind a large plant now being equipped with alternating apparatus for lighting and power distribution on thoroughly modern and improved lines. In this case a system of three-wire low-tension mains is to be laid over a large area. These mains will be fed at street corners from specially designed transformers in ventilated manholes. These transformers are to be of 100 kilowatts each, and are to have a core loss of only 500 watts, or one-half of 1 per cent. of the capacity. The efficiency of these transformers at one-quarter load will be higher than at full load, the principal loss being in the copper. Thus a transformer may be made to fill the same functions as a direct-current feeder. If we are willing to introduce some drop between generator and main, we can get high light-load efficiency with moderate cost, and we shall retain the important advantage that transmission is possible over long distances, with small losses, through the use of high voltage.

In no branch of electrical work has the improvement of recent years been more marked than in the manufacture of transformers. This improvement has not been brought about by any radical discovery as to the principles involved,

* Paper read before the Nineteenth Convention of the National Electric Light Association, May 5, 6, and 7, 1896.

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but simply by study of the economic conditions. The quality of iron is a most important matter in building transformers, and the methods of handling and annealing are almost equally so. Then the proportions by weight of iron and copper may be varied through a wide range, and the plan of arrangement of coils and iron are susceptible of endless variation. Every change of plan may affect the properties of the transformer as to self-induction, magnetising current, hysteresis, eddy currents in core and copper, resistance loss, and regulation. Thus there is much room for judgment in the design or purchase of transformers. At the price for which transformers can be bought it is folly to use bad ones. Thousands of transformers are in use to-day that are fit for nothing but the scrap pile, and many are now being manufactured and sold that are no better.

Regulation.—The cause of bad regulation in most existing alternating plants is that each individual installation is connected to a separate transformer, and that in these transformers, and the wiring connected to them, there are losses varying with the load, which, of course, cannot be controlled from the station. Since regulation is a matter of most vital importance, we see that with primary distribution good regulation in transformers is imperative. To make transformers of specially good regulation something must be sacrificed, either in economy of first cost or in light-load efficiency, or in both. Thus there is always an appreciable drop through resistance of wire in transformers, and this, combined with the drop in primary and secondary wiring, gives rise to serious vibrations in pressure on lights at different points. Another fruitful source of potential variations on alternating circuits is found in the self-induction of circuits and also in the self-induction of transformers. The E.M.F.'s introduced by self-induction being out of phase with the current, are variable in their effect, and give rise to troubles that sometimes seem erratic, although in reality they are governed by well-defined laws, which, if properly observed, enable us to obtain accurate results.

Motors.—Until very recently the operation of motors from alternating systems has been practically out of the question, since no suitable motor has been obtainable. Thus alternating apparatus has been available only for lighting, while in direct-current stations motor load during the day has been a most important source of profit. It may be mentioned here that while incandescent lighting is at the present time meeting sharp competition from other forms of illumination, the electric motor is growing very rapidly in popularity. It has taken the public a long time to gain confidence in electric power and to realise its usefulness. It is only within very recent years that large manufacturers have begun to use electrical power distribution to any great extent. At present the work is being carried on very actively, and highly successful and economical results are being obtained in many large mills. As a means of power distribution, even for short distances, electricity has no rival; while for lighting, its advantages, though great, are relatively much less positive. Although for many years efficient electric motors have been in general use, there are many central stations in whose business power distribution has not been a very important factor. There are several causes which have tended to restrict the use of electric power, among which we may mention the follpwing: Voltages that have been available for direct-current work have not admitted of transmission to considerable distances. Motors have required a certain amount of attention, which users were sometimes unwilling to bestow.

In certain classes of manufacture, the sparking of motors has been a source of danger. The most important cause, however, has been that, as a rule, the same apparatus has not been available for the operation of lights and motors; consequently, central stations have not been in a position to make attractive propositions to large users of power. The introduction of good alternating-current motors has opened a new era in electric power distribution, and seems to promise a great extension of its uses. With these motors the difficulties of distance are practically eliminated, since there is virtually no limit to the voltage which can be used. The mechanical features of the motor are near perfection, since it requires no care save what must be bestowed on its self-oiling bearings. These motors can be so arranged that they may be operated with perfect safety in any part of a powder-mill or oil refinery, and, in fact, a number of them are being operated now in highly explosive atmospheres, where a spark would work destruction.

With facilities for electric power transmission thus improved, we may look for great developments in the sale of power from central stations. When it is profitable for large manufacturing establishments to put in electric plants for the purpose of distributing power on their own premises, there should certainly be profit in the sale by electric companies of power to large as well as small manufacturers. The actual saving in fuel effected in the operation of a large mill by electricity for power distribution is ordinarily very large, often as much as 50 per cent. With good equipment this is, however, only a small part of the saving effected by electrical distribution. The cost of coal seldom amounts to more than half the expense incident to the production of power, and in most cases it is a much smaller proportion of the total. If power is obtained from a central station the coal is bought cheaper and used more economically, while the other items of expense will in many cases be almost a clear saving. The introduction on any large scale of electrical power distribution, of course, requires the investment of a good deal of money in motors and alterations of plant. Power users are often slow to make these investments because they are not familiar with electrical apparatus and do not realise the advantages to be gained. Repeated investigations have proved that users almost always far underestimate the cost of power. It is the business of the central-station manager to correct these misconceptions, and to awaken interest in electrical methods. Of course, many companies are working zealously just on these lines. There is no question, however, that there is in many of our large cities a large amount of undeveloped power business. If electrical manufacturers can induce large millowners to put in plants for electrical power distribution, central stations should be able to sell power to similar concerns.

The following facts concerning sale of alternating power apparatus by one company alone will illustrate the hold which the modern improvements above mentioned have already taken upon the industry of the country. The first three-phase apparatus made in this country was put in operation 2½ years ago. Since then that company has put in operation 33,500 h.p. capacity in three-phase generators, 10,000 h.p. in three-phase induction motors, 14,800 h.p. in monocyclic generators, 6,000 h.p. in three-phase synchronous motors, 10,560 h.p. in rotary converters, and 42,000 h.p. in transformers used for power purposes; the average capacity of the latter being 16 h.p., and the largest having a capacity of 1,100 h.p. The production of this apparatus has involved the complete design and development of about 30 new forms of dynamos and 33 new forms of motors; each machine so developed involving the construction of new patterns and special tools, which, with drawings, etc., cost in the average about 1,000dol. for each new machine. The development of so large a number of different machines has been made expedient by the engineering conditions that have been met. The matters of speed, frequency, voltage, and capacity must all be considered in deciding upon the best apparatus for any given purpose; and, of course, it is, generally speaking, unwise to use anything unsuitable, even though it be of standard production, and for that reason desirable. The expense involved in the production of all these machines is great, but it is in the long run money well invested, since it puts the manufacturers in a position where they can bid to advantage on the apparatus best suited to any case. It also brings a fund of experience that may be of more value than the tools, patterns, and drawings. The uses to which all this apparatus has been put are various. All sorts of new problems have presented themselves, and have been solved in widely different ways suited to the conditions. In many cases the apparatus built has been of types radically different from anything previously produced. In the past the principal production of American electrical manufacturers has been from standard lines of apparatus, and we still endeavour to

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keep up this most economical and excellent practice. Since, however, we are now constantly called upon to produce special apparatus, we try to so standardise and systematise our methods that new work can be turned out promptly and economically and without risk of failure. The different methods of distributing power and light by alternating currents can best be illustrated by diagrams showing the connections used with each. We will briefly review some of the applications of the systems now in general use.

Fig. 1 shows the three-phase system as ordinarily applied to the transmission of power for lighting and other purposes over long distances. The generator may be of any convenient voltage, since step-up transformers are used. These

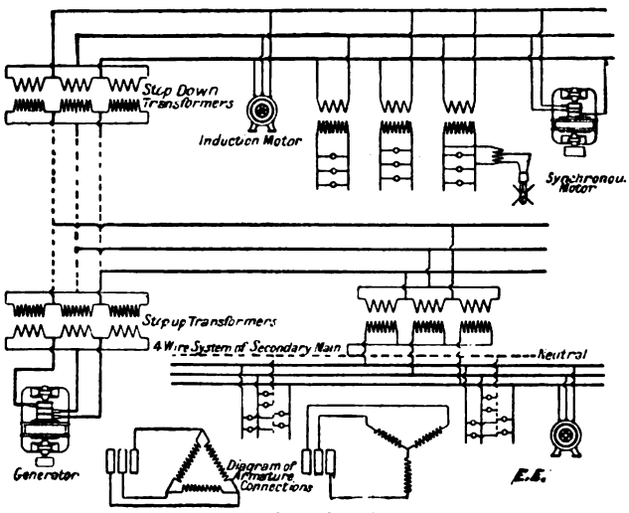

FIG. 1.—Three-Phase System.

transformers are in three units, or groups, any two of these units being available to transmit a large proportion of the power in case one is disabled. Two sets of step-down transformers are shown, one supplying 1,000-volt distributing lines, and the other supplying a system of four-wire secondary mains. With a given lamp voltage such mains give a slightly better copper economy than the ordinary three-wire system, and afford an excellent means of secondary distribution. Such a system as is illustrated in this figure will give excellent service in almost any town, the low-tension mains taking care of the thickly built-up portion and carrying the bulk of the lighting load, while the high-tension distributing system covers all outlying portions and operates large power units. A number of large plants have been installed within the last two years, using the three-phase system, as here shown.

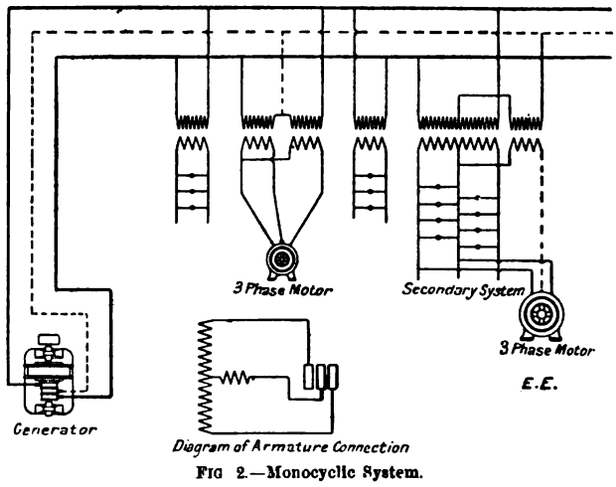

FIG 2.—Monocyclic System.

Fig. 2 shows the connections for distribution by the monocyclic system. Here all lights are connected single-phase between a single pair of conductors leading from the generator, the motors being operated from the same single-phase circuit in combination with a third conductor leading from what is known as the "teazer coil" on the generator. Here the simple three-wire system is used for secondary distribution, and if it is desired to connect motors to the low-tension mains, a supplementary transformer is used, which supplies a secondary teazer wire; to this and the outside wires of the three-wire system the motors are connected.

The great merits of the monocyclic system are that the number of conductors required for lighting and power distribution is reduced to a minimum, and that no unbalancing is possible. The operation of three-phase motors from this system is in all practical respects the same as when they are run from three-phase circuits.

Fig. 3 shows the connections of the two-phase system, with distribution by four conductors. Here the lighting is divided between two separate circuits, which must be kept balanced within certain limits, depending upon the regulation of the generator or the amount of care that can be given to the adjustment of pressure on the different

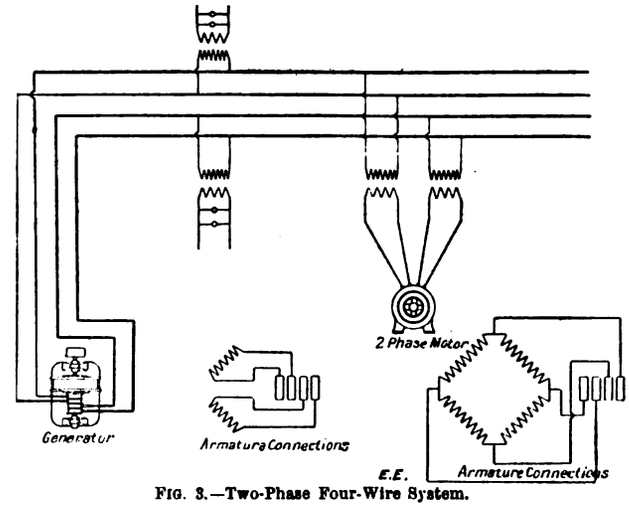

FIG. 3.—Two-Phase Four-Wire System.

sides. Where motors are run, the two circuits must be brought together. There is no economical and convenient way of operating secondary distribution from this system. Two independent three-wire systems could be operated, but these must be brought together when motors are to run. The complication of balancing such a system would be prohibitory. The two-phase four-wire system can be operated either from a generator with two independent circuits, or all four conductors can lead from one armature winding. Certain advantages may be claimed for both methods, and both have disadvantages.

Fig. 4 shows a method of single-phase lighting distribution from a two-phase dynamo. Here the two single-phase leads are taken out at points 180deg. apart on a progressive armature winding. At points 90deg. from those leads two other leads are brought out; each of the latter can be used with the pair of single-phase leads to run one-half the

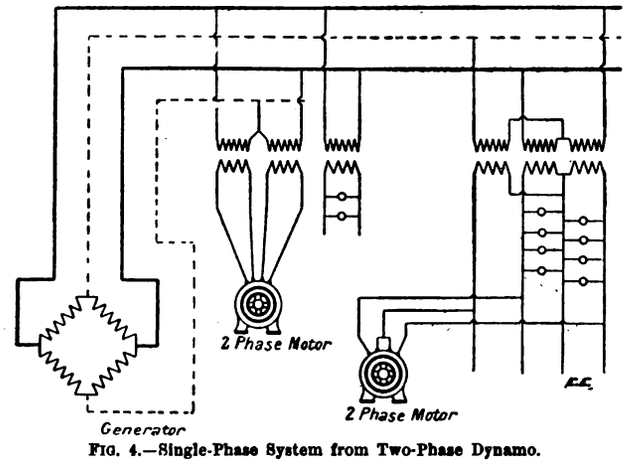

FIG. 4.—Single-Phase System from Two-Phase Dynamo.

capacity of the machine in two-phase motors. These two power leads cannot, however, be brought together. The greatest disadvantage of this system is that, when carrying a single-phase load, a large proportion of the armature conductors are ineffective, and simply introduce useless resistance and self-induction in the circuit. Thus with the same loss the generator will deliver 42 per cent. more power as a quarter-phase machine than it will as a single-phase machine.

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Fig. 5 illustrates the two-phase three-wire system, which has been used to some extent both for high-tension distribution and for distribution by secondary mains. The principal advantage in this system is that it requires one less conductor than the four-wire two-phase system. Its disadvantages are that the insulation of the apparatus is subjected to a voltage 42 per cent. higher than that which is available in transmission, and that the self-induction in the lines and transformers causes an unbalancing of the voltages on the two sides of the system, accompanied by

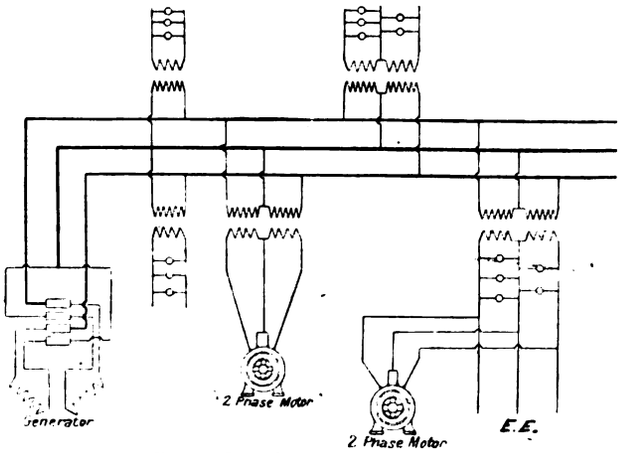


FIG. 5.—Two-Phase Three-Wire System.

the distortion of the phase variation. The extent of this unbalancing depends upon existing conditions, and is very different in different cases.

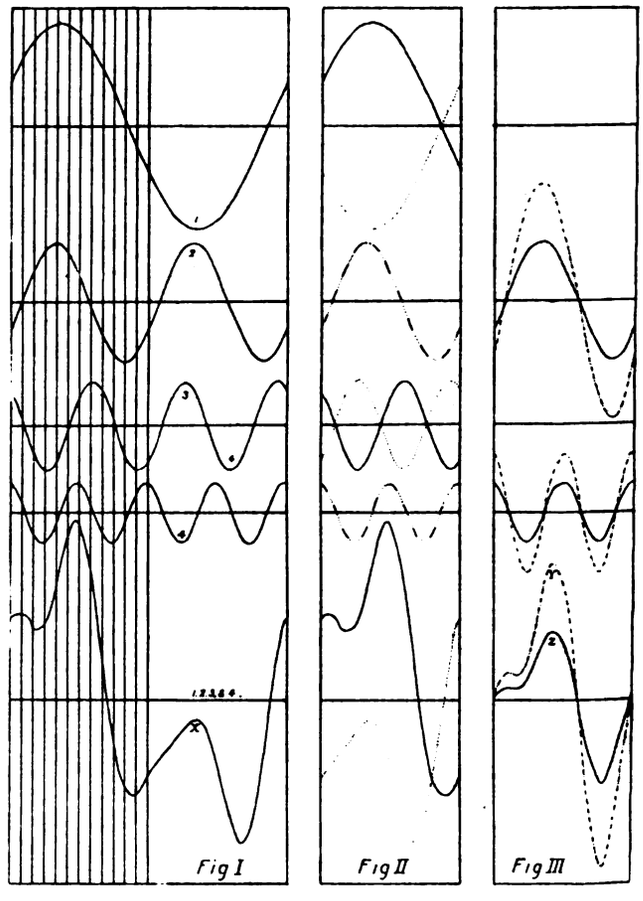
(To be continued.)

A SIMPLE METHOD OF ANALYSING PERIODIC CURVES.*

BY E. BASIL WEDMORE, STUDENT.

No excuse is needed for bringing this subject before you this evening. The mathematical electrical engineer in all problems dealing with alternating or other periodic currents has to deal with forces and quantities that vary as some harmonic function of the time. We know that it is a common practice to assume that these variations follow a simple sine law. Where this is not admissible many problems are quite insoluble, unless we use some method of analysing the law of variation into a series of simple sine functions, which can then be dealt with separately by the usual methods. We believe that there are many who avoid such calculations solely owing to their not being acquainted with any simple method of analysing harmonic curves, or owing to their not having the necessary instruments or apparatus for using one of the methods more generally known. The curves of voltage, current, and magnetisation are to electrical machinery what the indicator diagram is to the steam-engine; and we venture to believe that the solving of many problems depending on the peculiar form of these curves, such as the best form of curve for incandescent lighting, or transforming under various conditions, might be considerably simplified by studying the analysis of the curves. The analysis might form a half-way station at which the manufacturing and lighting engineers might meet—the one studying the qualitative effects of the various components on the apparatus that he uses, and the other studying the methods of producing the various components required.

But to return to the subject of this paper. I propose, firstly, to enunciate the principle; secondly, to give examples of its application; and then to prove the method analytically and geometrically. Special attention will be given to those cases more immediately applicable to electrical problems and to the effect of errors in the curve analysed. A few special cases will also be pointed out where rather interesting points arise. It may be as well to point out at this juncture, in case any present are not acquainted with the fact, that Fourier has shown that any periodic function is the resultant of a number of simple harmonic functions, which, as we know, may be represented by sine curves. The object of the analysis is to find these component curves, their phase and amplitude. It has been pointed out that the method about to be described is analogous in some respects to the use of chemical reagents in chemical analysis. Each application of the process separates out from the given curve those component sine curves whose periodicity is some simple multiple of the divisor or reagent used. Each of the prime numbers may be used as a reagent, and will separate out all those curves whose periodicity is some simple multiple of the number used. For the appplication of this method it is necessary to obtain one complete period of the curve to be analysed. (It is hardly necessary to point out that one complete period must contain a whole number of periods of each component). The method consists of a continual application of the following process: "Draw the curve so that the independent variable, say time, is horizontal. Divide the curve vertically into any number of equal parts, say N parts. Superpose the parts, and algebraically add them." The result will be another curve consisting only of those components whose periodicity, as compared with that of the original curve, is some simple multiple of N, all other components having been eliminated. Thus in Fig. 1 we have one period of a curve, X, composed of four components shown above it and numbered 1, 2, 3, and 4. The figure is divided into two parts (*i.e.*, N=2), and in Fig. 2 the parts are superposed, their algebraical sum being shown in Fig. 3. Here it will be seen that curves 1 and 3, having one and three periods respectively, have been reduced to zero, 1 and 3 not being equal to N or a multiple of N; while 2 and 4, whose periodicities are respectively equal to N and a multiple of N, have been reproduced; with their amplitudes, however, doubled, or multiplied by N. The component curves, Nos. 1,



2, 3, and 4, are given only to show the effect of the process when applied to curve X, and have nothing to do with that application. We see that by operating on X with the number "2," we have obtained a curve, Y, consisting only of those curves whose periodicity is some multiple of 2, with their amplitudes doubled. If, now, we reduce the amplitude of Y by one-half, we shall obtain a curve, Z, which contains only half the components. For the complete analysis of the curve it would be necessary to proceed as follows, being careful always to reduce the amplitude of each curve obtained to its original value—*i.e.*, divide it by N—before operating with it: (1) Divide Z into two parts and proceed as before, thus obtaining component 4 (having a periodicity = twice that of curve operated upon); (2) subtract 4 from Z, and thus obtain 2. (Z − 4 = 2 + 4 − 4 = 2); (3) subtract Z (that is, 2 and 4) from X, and you will obtain 1 and 3 combined $\{(1+2+3+4)-(2+4)=(1+3)\}$; (4) divide this curve (1 and 3) into three parts and proceed as at first, and you will obtain No. 3; (5) subtract No. 3 from 1 and 3, and you will obtain No. 1.

We have now obtained all the components, and each in its respective position with regard to the original curve. Fig. 4 contains the complete analysis. The figure is complicated somewhat by the necessity of reducing the amplitude of curves when obtained by addition of ordinates, and the number of curves to be drawn has been increased by the necessity of spreading the analysis over three lines for the sake of clearness.

* Paper read at a students' meeting of the Institution of the Electrical Engineers.

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If the work is done on a larger scale, this is quite unnecessary. The curves drawn in full, with the exception of the first one, are the result of a complete operation, the other curves being intermediate steps. The dotted ones are curves redrawn merely for convenience in superposition. (This is quite unnecessary after one has obtained a little experience.) The dot-and-dash curves are curves as first obtained, which require to have their amplitudes corrected. The curves are numbered in the order in which they are obtained. Curve 2 is X superposed. Curve 3 is the same as Y, and curve 4 is Z, and contains all the even-numbered components. Curve 4 is bisected, and the two halves being superposed we obtain curve 6, which, reduced by half, gives us 7, one of the components (No. 4, Fig. 1). Subtracting curve 7 from 9 (which is 4 reproduced) we obtain 10, the second component. We now return to the original curve and operate with "3." The parts are superposed on the right-hand side of the figure. Curve 13 is the algebraical sum, and 14 is 13/3, and is the third component. Subtracting 16 (which is = 4) from 1 we obtain 17, which consists of components 1, 3, 5, etc. (the odd numbers). Subtracting 14 from 17 we obtain 18, which is the first component. We see that curves 18, 10, 14, and 7 are respectively similar in all particulars to Nos. 1, 2, 3, and 4, in Fig. 1. Twenty-four ordinates were used in this analysis, but the lines have been left out for clearness. The first 12 are shown in Fig. 1. Of course squared paper might have been used. By the use of a proportional compass, set to make the amplitude corrections, we might have left out all the curves except the six shown in full line, four of which are components; and in Fig. 10, which is the analysis of a transformer curve, to be again alluded to, we might have drawn the components straight away.

A very simple calculation explains the curious properties of periodic functions which enable us to obtain our results in this simple manner. Let N = number of parts, and P = number of periods of any component. We may write the P^{th} term of Fourier's series thus:

$$P^{th}\text{ term} = A_\rho \sin P \frac{2\pi}{T}(t+\phi_\rho).$$

After dividing the curve into N parts, the parts may be represented by the following:

$$1st = A_\rho \sin P \frac{2\pi}{T}(t+\phi_\rho);$$

$$2nd = A_\rho \sin P \frac{2\pi}{T}\left(t+\frac{T}{N}+\phi_\rho\right);$$

$$3rd = A_\rho \sin P \frac{2\pi}{T}\left(t+\frac{2T}{N}+\phi_\rho\right);$$

$$last = A_\rho \sin P \frac{2\pi}{T}\left(t+\frac{(N-1)T}{N}+\phi_\rho\right).$$

We note that each term differs (in phase) from the preceding one by an equal amount:

$$P\frac{2\pi}{T}\times\frac{T}{N} = 2\pi\frac{P}{N}.$$

The sum of these expressions, which, of course, represents the resultant of the superposition, is as follows:

$$\Sigma_\rho = A_\rho \frac{\sin P\pi}{\sin\frac{P}{N}\pi} \sin P\frac{2\pi}{T}\left(t+\frac{N-1}{N}\cdot\frac{T}{2}\cdot+\phi_\rho\right).$$

The coefficient of frequency with respect to that of the original curve—namely, P– being always a whole number, the factor:

$$\frac{\sin P\pi}{\sin\frac{P}{N}\pi}$$

will be zero, except where $\frac{P}{N}$ is also a whole number—*i.e.*, except when P = N or a multiple of N—in which case the factor takes the form $\frac{0}{0}$, the resolution of which leads to the value ± N.

If it is – N, then the right-hand part of the expression will also be negative, therefore their product or the whole expression will still be positive.

We may see also that in the case where $\frac{P}{N}$ is a whole number, the factor $P\frac{2\pi}{T}\cdot\frac{N-1}{N}\cdot\frac{T}{2}$, in the right-hand side, which, simplified, becomes $\frac{P}{N}\cdot(N-1)\pi$, will be a simple multiple of π, having no effect on the expression, as $\sin k\pi$ = zero, if k is a whole number; we may therefore eliminate it. Finally, then, we see that when P is not a simple multiple of N, the sum is zero, but when P is a simple multiple of N, making $\frac{P}{N}$ a whole number, the expression for the sum becomes

$$N A_\rho \sin P\frac{2\pi}{T}(t+\phi_\rho),$$

which is exactly the same as the original curve, except that its amplitude is multiplied by N, the number of parts. We note that the phase has not been altered.

For the benefit of those who may have found some difficulty in following the analytical proof, we propose now to give a proof by means of the clock diagram. We see that in performing the superposition we are really superposing a number of curves differing only in phase. We might take any number of periods of the original curve and superpose the whole upon itself either graphically, analytically, or by the clock diagram, N times, differing by $\frac{1}{N}$th of a period in phase. The result would be just the same. Thus in the analytical proof just given we see that the expressions representing the several parts are really expressions representing not only a short length of curve, but any number of periods of a periodic curve, and the proof given holds good whether we only take parts of a period, as in the figure, or whether we take any number of periods. Now, we know that we may represent any given combination of sine functions by vectors in a clock diagram, the lengths of the vectors representing amplitudes, and the angles between the vectors and some fixed line passing through the same centre representing the lags and leads. We know also that, if these vectors are projected on to a line at right angles to this fixed line, the lengths of the projected portions will give us at any moment the instantaneous values of the quantities represented by the vectors. One period of either component will be represented by one revolution of the corresponding vector, therefore one complete period of the combination will be represented by one revolution of the first component, two of the second, three of the third, etc. Fig. 5 shows a vector, O A, and "a" is its instantaneous value. O Y is our fixed line. If the figure was drawn at time 0, then $\sin^{-1} a$ = angle of lead. Fig. 6 contains a vector, one revolution of which gives us one period. The period has been divided into three equal parts, and the curves to be superposed are represented by the vectors I, I_a, and I_b, which we see differ in phase by one-third of a period. Now, according to our rule, as 1 is no multiple of 3, the quantity should cancel, and we see that it does so, whether we resolve the diagram by the parallelogram of forces or by projecting on to a fixed line. The projections are shown, and marked a, b, and c, and it is evident that $b + a - c$ = zero. If we had taken three periods—that is, three revolutions—and divided into three parts, the parts would have been coincident, and our vector would have been trebled, and our rule says that, as 3 is a multiple of 3 (P = 1 × N × 1), the resultant will be a curve of the same periodicity and phase, but of three times the amplitude of the original curve. Fig. 7 represents the curve X in Fig. 1 at time 0, also the result of the first operation, and we see that, while 1 and 3 are cancelled, 2 and 4 are doubled. Fig. 8 represents a combination divided into three parts, with the expected result. The clock diagram cannot, of course, be used for analysing the curve, as we cannot draw the vectors until we know the components. A certain artifice may be used, however, in certain cases, which will enable us to construct the clock diagram directly from the curve. (See Appendix.)

The curves obtained from alternators and transformers present a peculiar form of symmetry. The positive and negative portions of the curve are exactly similar in shape. This must be so from the symmetry of the apparatus producing the curve. If the north poles of an alternator were shaped differently from the south poles, we should then have an unsymmetrical curve. Perhaps some enterprising individual may yet show that this is the best arrangement. There is, at any rate, a very great difference between the components of a symmetrical and an unsymmetrical curve, in so far as that the one consists solely of components whose periodicity is an odd number as compared with the original curve, while the components of the other must be even, or odd and even. This will be comprehended at once on inspecting Fig. 10, where we see that if the curve (No. 1) were bisected and superposed the result would be zero, showing that there cannot be any components with periodicity = 2 or a multiple of 2. If, as in Fig. 11, No. 2, we obtain looking-glass symmetry *i.e.*, the positive or negative parts symmetrical in themselves—then there can be no difference of phase between the component curves. Where, as in Fig. 11, there are only two components, the vertical height, measured one-quarter period from zero, equals the sum or difference of the components, and the mean ordinate multiplied by $\frac{\pi}{2}$ equals the principal ordinate ± $\frac{1}{P}$ times the Pth ordinate; from which equations we may obtain both components.

With regard to the effect of errors in working the method, or of errors in the original curve, there are several points to be noted. Firstly, if we could remove the components from the curve and leave behind only the errors, these would form a

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curve of irregular form, which might nevertheless be analysed into a number of component sine curves of various periodicities. As the curve would be very irregular, a great many components would be required to accurately represent it. However, the point is that in this error curve there is a component of periodicity = 1 (its value might, of course, be zero), there is a component of periodicity = 2, of periodicity = 3, etc. The amplitudes of these components may be small in comparison with that of the error curve, and ∴ very small with respect to those of the original curve. Now, when we analyse the original curve, it is evident that the component of the error curve of periodicity = 2 will be removed with the component of the original curve of periodicity = 2, and so with any other component: each component we separate from the original curve will be erroneous to the extent of the component of the same periodicity of the error curve. But what of the other components? Let us consider the first 24 only, and assume that we have analysed the curve to the sixth, then we have 18 to consider. Now nine of these will disappear, as we can easily show. Fig. 12 contains two curves, No. 2 having twice the periodicity of No. 1. If 1 and 2 were added, we should add to the positive part of No. 1 just as much as we subtracted from it, and the same with the negative part; in other words, the area would remain unaltered. If, therefore, we take any curve

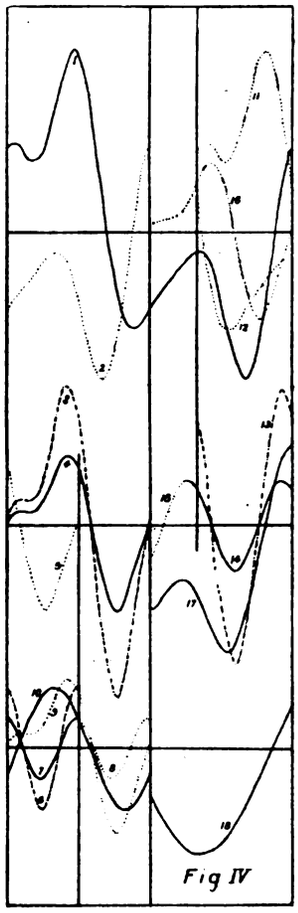

Fig IV

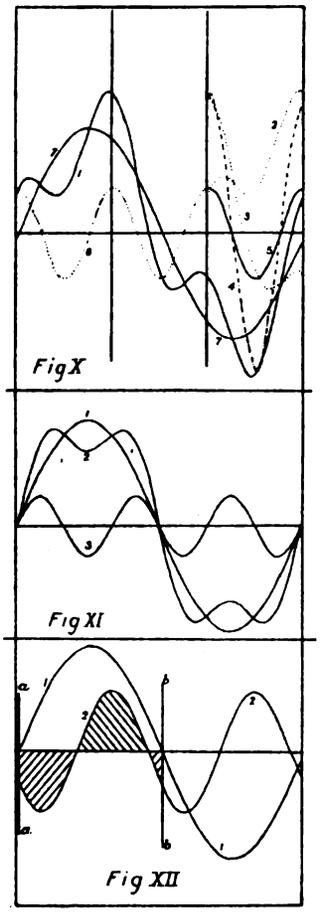

Fig X

Fig XI

Fig XII

containing errors whose periodicity is an even multiple of that of the curve, these errors will be eliminated by drawing a smooth line through the inequalities—*i.e.*, keeping the area the same—or by finding the amplitude by taking $\frac{\pi}{2}$ times the mean ordinate. Therefore all even-numbered ordinates in the error curve disappear. With regard to the others, let us consider the seventh. As it is a prime number, it would appear in the first component. If its zero coincides with that of that component, then the effect will be that the area of each half of the curve will be increased or diminished by an amount equal to that of one-half period of the error component. If the maximum of the error curve coincides with the zero of the other, then the areas will not be altered, and the error will cancel. The probable error per ordinate will be about two-thirds of one-seventh of the mean ordinate of the error component.

The same reasoning applies to the other components, the particular curve they appear in depending on what number their periodicity is a multiple of. We find, therefore, that the error in any one ordinate of any component will probably be much less than the mean error in the ordinates of the original curve. In fact, if we analyse an erroneous curve, and then reconstruct it from its components, its last state is much better than its first. If, on the whole, the positive errors are greater than the negative, or *vice versâ*, then the difference will be removed with the constant term.

It is essential in this method, as in others, that the constant term, if there be one, be eliminated at the outset. There rarely is one, however. To give a practical illustration; I have the analysis of a curve that might have been taken from a transformer. The mean error in the ordinates is 2 per cent. There are two components. The mean error in the smaller one is ½ per cent., in the larger one ¼ per cent.; and, as these components are themselves smaller than the original curve, it is evident that most of the errors have been removed. It is possible, by performing the analysis arithmetically instead of graphically (by writing down the ordinates in figures and performing the operation on them arithmetically), to reduce the error to smaller proportions, even if only working to two significant figures. We might point out that, if there is a large error in one or more ordinates, it will be spotted at once while working.

With regard to the arithmetical method of performing the analysis—which is the most accurate where it can be applied—the procedure is the same as that used in the graphical application. We give below the complete analysis of the curve X (Fig. 1) to correspond with Fig. 4; also the analysis of curve No. 1 (Fig. 10) showing the method of finding phase and amplitude. You will see that it only takes seven columns of figures to separate four components, and as three columns are

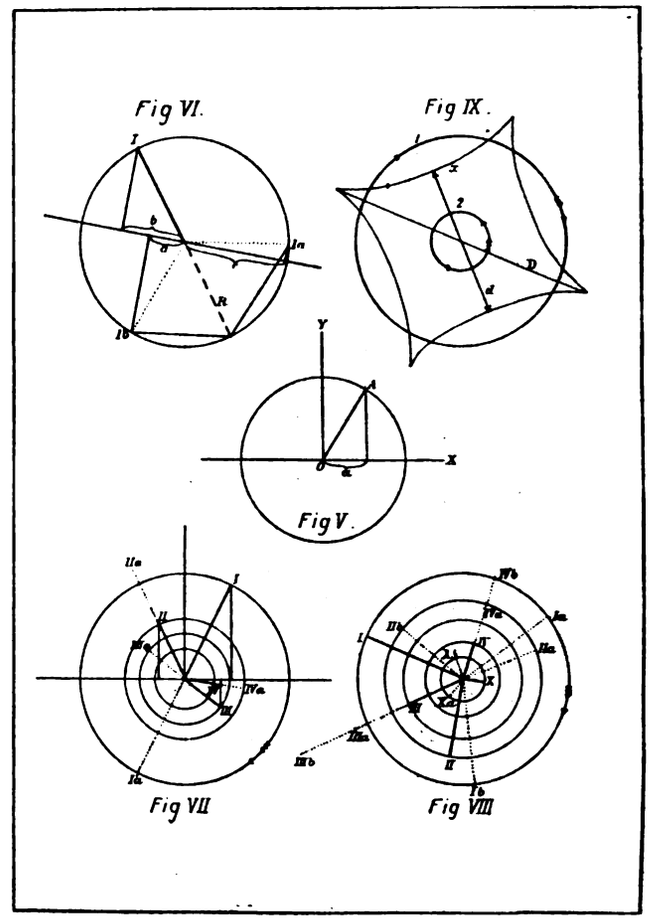

Fig VI.

Fig IX.

Fig V.

Fig VII

Fig VIII

taken up by the question and answer, one can hardly consider the method a slow or tedious one. If the curves are plotted to a large scale on squared paper, and a proportional compass is used, the work may be done very rapidly. It has already been pointed out that in Fig. 10 the answer might have been written down straight away, and when we consider that 15, or even 9, ordinates would have given us fairly accurate results, we see that the work of analysis by this method is reduced to a minimum. The number of ordinates taken must be a multiple of the periodicities of all the components we wish to separate, and we must have at least three points per period of any curve we wish to find, as two points leave both amplitude and phase indeterminate. This, however, is not very serious. In electrical problems 15 ordinates will suffice to find the first, third, and fifth components, and if we wish to find the seventh we must redivide our curve. When a small number of ordinates are taken, it is best that their number shall be an odd multiple of the periodicities of the components to be separated.

It will be seen that as columns B, E, I, J, and M, and parts of G and L, are only written so that figures may be added or subtracted conveniently; they are unnecessary. The fingers of the left hand may be used to mark the figures to be operated on. Thus, by putting the thumb and first finger on lines 0 and 12, in column A, and slipping them down one line at a time while adding, we can write column C without first writing column B, which is merely A repeated from line 12 downwards,

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	A	B	C	D	E	F	G	H
Time.	Original curve.	A superposed.	A + B.	C/2 = Comp. 2 and 4.	D superposed.	D + E.	F/2 = Comp. 4.	D − G = Comp. 2.
0	5·63	− 5·17	0·46	0·23	3 71	3·94	1·97	− 1·74
1	5·79	− 4·01	1·78	0 89	0·47	1·36	0 68	0·21
2	4·81	− 3·03	1·78	0·89	− 3 47	− 2·58	− 1·29	2·18
3	5·24	− 2 06	3·18	1·59	− 5 53	− 3·94	− 1 97	3·56
4	7 97	− 1·35	6 62	3·31	− 4·67	− 1·36	− 0·68	3·99
5	11·20	− 1·90	9 30	4·65	− 2 07	2·58	1 29	3·36
6	11 89	− 4·47	7·42	3 71		G continued downwards ☞	1·97	1·74
7	8 73	− 7·79	0·94	0·47			0·68	− 0·21
8	2·77	− 9 71	− 6 94	− 3·47			− 1·29	− 2·18
9	− 2 94	− 8·12	− 11 06	− 5 53			− 1·97	− 3·56
10	− 6·06	− 3·28	− 9·34	− 4·67			− 0·68	− 3·99
11	− 6·39	2·25	− 4 14	− 2 07			1 29	3·36
12	− 5·17			L continued upwards ☞	− 2·34	0·23	− 5·40	− 3·07
13	− 4 01				− 0 31	0·89	− 4·90	− 4·59
14	− 3 03				1·87	0·89	− 3·92	− 5 79
15	− 2·06				2·98	1·59	− 3 65	− 6·62
16	− 1·35	2 77	5 63	7 05	2·35	3·31	− 4·66	− 7·01
17	− 1 90	− 2·94	5 79	0·95	0 32	4·65	− 6 55	− 6·87
18	− 4·47	− 6 06	4·81	− 5·62	1·87	3·71	− 8·15	− 6·31
19	− 7·79	− 6·39	5 24	− 8·94	− 2·98	0·47	− 8 26	− 5·28
20	− 9·71	− 5·17	7 97	− 6·99	− 2 33	− 3·47	− 6 24	− 3·91
21	− 8 12	− 4·01	11·20	− 0 83	− 0 31	− 5·53	− 2·59	− 2·28
22	− 3·28	− 3 03	11·89	5 62	1 87	− 4·67	1·39	− 0·48
23	2·25	− 2·06	8 73	8·92	2 97	− 2·07	4·32	1·35
	Original curve.	A superposed.	A superposed.	A + I + J.	K/3 = Comp. 3.	D repeated	A − D = Comp. 1 and 3.	N − L = Comp. 1.
	A	I	J	K	L	M	N	O

The complete analysis of a curve of four components.

A	B	C	D	E	F
Original curve.	A superposed.	A superposed.	A + B + C.	D/3 = Comp. 3.	A − D = Comp. 1.
5·0	5 8	− 5·1	5·7	1 9	3·1
7·5	0 4	− 4·6	3·3	1·1	6·4
3·7	− 8·0	− 4·7	− 9·0	− 3·0	6 7
5·8				1·9	3·9
0·4				1·1	− 0 7
− 8·0				− 3 0	− 5 0
− 5·1				1·9	− 7·0
− 4 6				1·1	− 5·7
− 4·7				− 3 0	− 1 7
			Sum	18·0	40 2
			Mean ordinate	2·0	4 5
			Mean ord. × π/2	3·14	7·06 - amplitudes

First ordinates 1·9 and 3·1
Reduced to unit amplitude 0·633 and 0·443
Sin⁻¹ 0·633 and sin⁻¹ 0·443
= 39° = 26°
39°/3 = 13°

Complete analysis of transformer curve (see Fig. 10).

In the above, the correct values for the amplitudes are 3 and 7, so small errors have crept in owing to our using only two figures and nine ordinates. The phase, however, is correct. $\sin^{-1} 0{\cdot}633$ gives us 39°; but, as this component has three periods to one of the original curve, we must reduce this lead by one-third to make it comparable with the other.

APPENDIX.

Where there are only two components we may construct the clock diagram direct from the curve by a simple artifice. This method, however, is not so quick or accurate as those just described, and is given here only because of its theoretical interest.

If we combine two simple harmonic motions, of the same amplitude but differing in phase by one-quarter period, at right angles to each other, we shall obtain circular motion. Thus, if we combine, at right angles, the vertical ordinates of two similar sine curves, differing in phase by one-quarter period, we shall obtain a circle. If, therefore, we take the vertical ordinates of two periods of the given curve differing in phase by one-quarter period, and combine them at right angles, the resultant will be a combination of circular motions.

Fig. 9 gives a curve obtained in this manner from a curve of two components of periodicities 1 and 3. The minimum diameter of the figure, d, obviously corresponds to the position where the circular motions are opposed to each other, while the maximum, D, is produced when the motions assist each other. $\frac{D-d}{4}$ gives us the amplitude of the smaller component, and $\frac{D+d}{4}$ gives us the amplitude of the larger component. From the position of either diameter with respect to the original ordinates we may easily obtain the phases, remembering that the circles are travelling in opposite directions, because when we shifted the original curve through one-quarter period we shifted the smaller component through three-quarter periods. If the second component had had five periods, we should have shifted it through ¼ periods, which has the same effect as one-quarter, and the circles would revolve in the same direction. If the smaller component had had an even number of periods, we should have shifted it through a certain number of half periods, the result of which would have been to have given us a diagonal line, which would have made the resultant figure elliptical.

We might analyse any curve by this process by the help of a few more artifices which enable us to eliminate groups of components, but the process is very tedious.

STAFFORD CORPORATION.

The electric lighting department accounts for the year ended on March 31, 1896 (five months' working only), have just been issued. The expenditure authorised was £15,000, but the actual expenditure has already exceeded that amount by £969. 1s. 8d. We give herewith an abstract of the revenue account, net revenue account, balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Expenditure.	£ s. d.	£ s. d.
To Generation of Electricity—		
Coal or other fuel	£50 0 0	
Oil waste, water, and engine-room stores	14 19 0	
Salaries and wages at generating station	74 4 0	
Repairs and maintenance as follows: machinery, instruments, and tools, £21. 6s.; accumulators and accessories, £7. 6s.	28 12 0	
		167 15 0
Distribution of Electricity:		
Repairs, maintenance, and renewal of mains and services, including wages and other remuneration to linesmen, fitters, labourers, etc.	23 6 8	
Repairs, maintenance, and renewal of meters, switches, fuses, and other apparatus on consumers' premises	10 0 0	
Public lamps—attendance and repairs	24 10 2	
		57 16 10
Rents, rates, and taxes		59 0 2
Management Expenses:		
Salary of auditors	4 4 0	
Stationery and printing	26 13 9	
General establishment charges	48 17 1	
		79 14 10
Law and parliamentary charges		39 9 3
Total expenditure		403 16 1
Amount carried to net revenue account		1,191 8 2
		£1,595 4 3
Income.		
Sale of current per meter at 8d. and 4d. per B T.U.		423 14 4
Public lighting		18 15 0
		442 9 4
Rental of meters and other apparatus on consumers' premises		16 1 6
		458 10 10
Rents		49 7 4
District fund—interest on loan	480 16 4	
Loans repayment account	411 8 4	
Towards incidental expenses, such as charges, stationery and printing, office furniture, etc.	195 1 5	
		1,087 6 1
		£1,595 4 3

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Dr. NET REVENUE ACCOUNT.	£	s.	d.
Balance from last account	2	12	0
Interest on mortgage	480	16	4
Instalments of principal of money borrowed	411	8	4
Balance carried forward	296	11	6
	£1,191	8	2
Cr.	£	s.	d.
Balance brought from revenue account	1,191	8	2
	£1,191	8	2

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—amount received as per account—Corporation loans on debentures	14,588	11	8
Balance at credit of profit and loss account	296	11	6
Sundry creditors	1,254	12	7
Balance at credit of loans repayment account	411	8	4
Amount due to bankers	340	0	9
	£16,891	4	10
Assets.	£	s.	d.
Capital account—amount expended for works	15,969	1	8
Stock of electric fittings, cable, etc.	311	11	5
Sundry persons for rental and fittings	610	11	9
	£16,891	4	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		25,455
Quantity sold { Public lamps	1,582	17,457
Quantity sold { Private consumers by meters	15,965	
Quantity used on works		2,188
Total quantity accounted for		19,735
Quantity not accounted for		5,720
Number of public lamps		4
Total maximum supply demanded (kilowatts)		49

TUNBRIDGE WELLS.

We give below an abstract of the accounts for the Tunbridge Wells electricity works for the period ending March 31, 1896 (about seven months). The amount authorised to be spent for the purposes of the undertaking is £25,000, of which £15,408. 18s. 9d. has been expended. It will be seen from the net revenue account that a profit of £737. 13s. 7d. has been made on the seven months' working:

Dr. REVENUE ACCOUNT.	£	s.	d.
Coal, or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	299	7	11
Oil, waste, water, and engine-room stores	24	15	11
Wages at generating stations	173	12	6
Repairs and maintenance, as follows: buildings, £10. 3s. 7d., engines, boilers, dynamos, exciters, transformers, motors, etc., other machinery, instruments and tools, accumulators and accessories, £16. 0s. 9d.	26	4	4
	524	0	8
Repairs, maintenance, and renewals of mains of all classes, including materials, and laying the same	0	11	3
Attending and repairs, and renewals of lamps	48	11	0
Rates and taxes	5	12	0
Salaries—engineer's department, £101. 2s. 6d.; accountant and clerical staff (transfer), £50; salaries or commissions of collectors, £8. 14s. 2d.; stationery and printing, £30. 6s. 4d; general establishment charges, £19. 14s. 8d.	209	17	8
Insurance, etc., £4. 4s. 9d.; private works, *per contra*, £119. 9s. 2d.	123	13	11
Total expenditure	912	6	6
Amount carried to net revenue account, £670. 4s. 7d.; balance carried to next account to provide for bad debts, £5	675	4	7
	£1,587	11	1
Cr.	£	s.	d.
Sale of current, per meter, at 6d. per B.T.U. to March 25, 1896	1,032	12	3
Minimum charges	2	10	0
Public lighting	350	2	11
	1,385	5	2
Rental of meters and other apparatus on consumers' premises	32	13	2
Private works (*per contra*)—transformer chambers, £44. 8s. 5d.; cable supplied, £97. 10s. 9d.	141	19	2
Extra tests	7	1	6
Compensation for damage to transformer	1	5	0
Charges for current at electrical exhibition	19	7	1
	£1,587	11	1

Dr. NET REVENUE ACCOUNT.	£	s.	d.
Balance brought forward	11	12	8
To balance carried forward (profit on seven months)	737	13	7
	£749	6	3
Cr.	£	s.	d.
Balance brought from revenue account	670	4	7
Electrical exhibition—excess of income transferred	79	1	8
	£749	6	3

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	25,000	0	0
Sundry creditors	495	4	7
Net revenue account—balance at credit thereof	737	13	7
Amount carried to revenue account to provide for bad debts	5	0	0
	£26,237	18	2
Assets.	£	s.	d.
Capital account—amount expended	15,408	18	9
Stores on hand at March 25, 1896—coal, £57. 15s. 11d.; oils, waste, etc, £15. 8s. 10d.; general, £24. 8s. 9d.	97	13	6
Sundry debtors for current supplied to March 25, 1896, and other debtors	714	7	7
Cash balances—on capital account, £9 591. 1s. 3d.; on revenue account, £51. 16s. 10d.; on deposit at 1½ per cent., £370	10,012	18	1
Cash in hands of electrical engineer	4	0	3
	£26,237	18	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		72,072
Quantity sold { Public lamps	19,873	60,571
Quantity sold { Private consumers by meter	40,698	
Quantity used on works		2,011
Total quantity accounted for		62,582
Quantity not accounted for		9,490
Number of incandescent lamps		7,066
Number of arc lamps		21
Total maximum supply demanded (kilowatts)		117·6

NELSON CORPORATION.

The following statement of accounts has just been issued by the above Corporation. It will be seen that a net profit of about £256 has been made during the past year. The example of Nelson might well be followed by other corporations which have not yet dealt with the electric light question:

BALANCE-SHEET FOR YEAR ENDING MARCH 25, 1896.

Capital expended on March 25	£9,957 15 0
Revenue from electricity supply	1,251 9 0
Revenue from meter rents, etc.	29 19 8
Total revenue	1,281 8 8
Total costs	1,025 9 2
Net profit handed over to the district fund	255 19 6
Maximum load reached (kilowatts)	82
Number of 8-c.p. lamps connected on March 25	4,500
Number of units sold	64,981
Price charged	5d. and 4d.
Average price obtained	4·62d.

COST OF PRODUCTION.

Generation and Distribution.	£	s.	d.		Per unit sold. d.
Fuel	100	12	11	...	·37
Oil, waste, water, and engine-room stores	7	4	2	...	·03
Salaries and wages at generating station	221	7	8	...	·82
Repairs and maintenance, etc.	20	6	2	...	·07
Works cost	349	10	11	...	1·29
Rents, rates, and taxes	24	0	0	...	·09
Management expenses, printing, etc.	78	3	8	...	·29
Sinking fund instalment	249	18	8	...	·90
Interest on loans	323	15	11	...	1·20
Total costs	£1,025	9	2	...	3·77

COMPANIES' MEETINGS AND REPORTS.

WEST COAST OF AMERICA TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held last Friday at Winchester House, E.C., Mr. J. Denison Pender presiding.

The **Chairman**, in moving the adoption of the report, a summary of which has already appeared in our columns, said the gross income for the year had been £32,930, being an increase of £11,176 over that of the previous year, but this included a rebate

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of £3,140 made to the Company out of the international traffic receipts by two of the associated companies. During the early part of last year the local traffic receipts were sufficiently favourable to justify the hope that the year's working would result in their making both ends meet, but later on the local traffic fell off, mainly in consequence of the stagnation in the nitrate trade, and this falling off lasted during the remainder of the year. Only the rebate had enabled them to meet their working expenses and pay their debenture interest. The expenses for the year had been £776 in excess of those for 1894, principally owing to the higher sterling value of the Chilian dollar. The completion of the arrangements among nitrate producers to restrict the output for a term of years and the disappearance of the friction hitherto existing between Chile and Argentina would, he thought, produce a revival of trade on the West Coast, and have a beneficial effect on their local and international traffic. The latter class of traffic had grown steadily since the opening of the line between Valparaiso and Buenos Ayres in March, 1894. After referring to the excellent working of their system, the Chairman wished to make it clear that the special rebate which relieved them of what would have been a loss of £3,140 on last year's working must not be taken to mean that in the event of a deficit this year it would be wiped off in a similar way. Their normal proportion of the international traffic receipts was fixed at the commencement by the associated companies, and it was fully anticipated that this Company's share of the pool, added to their local traffic receipts, would be sufficient at least to pay their working expenses and the debenture coupons, if not to leave a balance over. Last year's working, owing to temporary causes, did not realise these anticipations, and having regard to the general policy which resulted in the formation of the Pacific and European Telegraph Company, and the alliances thereunder, the special rebate was allowed to this Company, it being, however, clearly understood that a precedent had not been thereby established. They were, however, really getting within measurable distance of making both ends meet.

The resolution was seconded by **Mr. F. Walters** and carried unanimously.

WEST AFRICAN TELEGRAPH COMPANY.

The report of the directors of the West African Telegraph Company, Limited, for the year ended December 31 last, to be presented to the general meeting to be held in London on 11th inst., states that the Company's revenue for the year amounted to £74,333, against which £17,474 is charged for ordinary expenses and £6,298 for expenditure relating to repairs of cables, etc. After providing £876 for income tax, and £25 due to revaluation of currency assets, there remains a balance of £49,660. From this amount there has been deducted £11,323 for interest on debentures and £12,333 for sinking fund, leaving a balance of £26,004, out of which the directors have placed £15,000 to the general reserve fund. For the six months ended June 30, 1895, an interim payment of 2s. per share has been paid, and the directors now recommend a final dividend of 6s. per share, making 4 per cent., free of income tax, for the year. The balance of £1,760 it is proposed to carry forward.

ELECTRIC TRACTION COMPANY, LIMITED.

The report of the directors for the year ended December 31 last states that the allotment of the Company's share capital took place on June 18, 1895 The whole of the share capital has been subscribed. The deferred shares are fully paid, and £2 per share has been paid on the ordinary shares. On June 18, 1895, the Company entered into a contract with the Central London Railway Company for the acquisition of the necessary land and the construction and equipment of the railway, with all its appurtenances, to the satisfaction of the railway company's engineers. Immediately after the execution of the above contract, this company proceeded with the compulsory acquisition of the properties required for the station sites and the generating depôt at Shepherd's Bush, with the result that, thus far, upwards of three-fourths of the total number of claims have been settled or adjudicated upon. This work is being pushed forward as quickly as possible, so that possession of station sites may be obtained to enable the work of construction to be commenced not later than July 1 next. The line from Shepherd's Bush to the Bank has been divided into six sections, and on February 19 last a selected number of firms were invited to tender for the construction of the tunnels and shafts and incidental work. A considerable number of tenders having been received the directors have entered into the following sub-contracts: sections 1, 2, and 3, Shepherd's Bush to Marble Arch, Mr. J. Price; sections 4 and 5, Marble Arch to Post Office, Messrs. Walter Scott and Co.; section 6, Post Office to Bank, Mr. G. Talbot. The arrangements with regard to the station at Liverpool-street are progressing satisfactorily. The prices at which these sub-contracts—which cover the principal part of the work of construction—have been let, and the cost of acquiring the station sites are fairly in accord with the estimate formed as to the cost of the undertaking, and confirm the directors' anticipation that the construction and equipment of the Central London Railway will be carried out within the contract price, with a fair margin of profit to this Company.

Direct Spanish Telegraph Company.—For the month of May the receipts were £2,396.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ecija (Spain).—The Municipal Authorities of Ecija want tenders by July 2 for a system of electric lighting for the town.

Cherbourg.—The French Ministry of Marine are asking for tenders, by June 18, for the supply of a quantity of electric fittings.

San Sebastian (Spain).—The San Sebastian Tramway Company ask for tenders, by July 1, for the application of electric traction to their line.

Benevento (Italy).—A concession for installing and working the electric lighting of the town of Benevento is open to be tendered for up to June 20.

Mako (Hungary).—The municipal authorities of Makö in Hungary are desirous of receiving proposals for the electric lighting of the town.

Utrera (Spain)—Tenders are wanted by the Municipal Authority of Utrera for the installation of electric lighting. The last date for receipt of tenders is July 1.

London, S.E.—Tenders are required for complete installation of electric lighting. For particulars apply by letter to Mr. H. Freeman, 44, Knatchbull-road, Camberwell, S.E.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years. Tenders should be sent in by August 31.

Gardia (Spain).—The Municipal Authorities of Gardia, in the province of Toledo, will proceed to adjudge the contract for the electric lighting of the town for 20 years on June 10. The annual payment suggested is 14,000 pesetas (about £560).

Ocana (Spain).—The Ocana Municipal Authorities are open to receive tenders, up to June 30, for the electric lighting and water supply of the town. The annual payment suggested is 10,000 pesetas (about £400). Ocana is in the province of Toledo.

Brussels.—Tenders will be received shortly (the exact date is not yet announced) at the Brussels Bourse for the material and work necessary to start an electric lighting installation at the fifth section of the central locomotive construction works at Malines.

Alberique (Spain).—The Municipality of Alberique, in the province of Valencia, want offers for the electric lighting of the town for a period of 10 years. The annual payment suggested is 3,250 pesetas (about £140), and tenders must be sent in by June 12.

Brussels.—On June 17 there will be a reallotment of contracts for the conversion to a system of electric traction of about 12½ miles of local light railway. Application for particulars (price 1fr.) should be made to la Société nationale des chemins de fer vicinaux, rue de la Science 28, Brussels.

Spandau.—Tenders are wanted at the Royal Small-Arms Factory for 900 incandescent electric lamps by July 17 and for 27,300 sets of arc-lamp carbons by June 12. Particulars are obtainable for 75pfg. (9d.) from Die Königl. Direktion der Gewehrfabrik (Geschäftszimmer No. 21), Spandau.

Alford (Lincs.).—The committee appointed for lighting the town are prepared, on and after June 5, to enter into a contract for lighting the town with gas or other light from August 14, 1896, to May 14, 1897. Tenders will be received up to June 6 at the office of the committee, West-street, where all particulars may be obtained. Mr. E. W. Rushton, clerk.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality. Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Dresden.—The Telegraph Department of the Saxon State Railways want tenders by June 10 for about 50 tons of galvanised iron wire (4 millimetres) and 10 tons of smaller sizes; also 3,700 glass jars (various) for battery cells, and 10,000 porcelain insulators large size and 2,000 of smaller sizes as well as 7,500 zincs for Meidinger and 1,000 for Leclanché cells. Particulars from Die Königl. Magazin-Verwaltung, Dresden-Friedrichstadt.

Burnley.—The Corporation invite tenders for the supply and delivery at their electric lighting station, Burnley, of armoured concentric underground cables. Specification, schedule of quantities, and form of tender may be obtained on application to Mr. W. R Wright, borough electrical engineer, on payment of £1. 1s., which will be returned on receipt of a *bonâ fide* tender. Sealed tenders, endorsed "Tender for Cables," and addressed to the Chairman of the Electric Lighting Sub-Committee, Town Hall, Burnley, must be delivered on or before the 24th inst.

Paris.—Tenders are wanted by the French Government for the supply of a quantity of material for batteries (12 lots). Application should be made to La Direction générale des Postes et des Télégraphes, Paris, rue de Grenelle 103, and tenders must be in by June 16, but application for permission to tender must be made at once. Tenders are wanted for the supply of a dynamo for the municipal generating station at the Buttes Chaumont. Application for permission to tender must be made at the Hotel de Ville before June 14, and tenders must be in by June 17.

York.—The North-Eastern Railway Company require tenders for the following articles during six months ended December 31, delivered carriage paid at the telegraph stores at York: (1) telegraph apparatus; (2) telegraph wires and line stores.

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Payment for each month's delivery will be made at the end of three clear months, or in cash less 2½ per cent. discount. Forms of tender may be obtained on application to Mr. Greaves, Telegraph Department, York, and tenders must be sent to the Secretary, York, sealed, and marked "Tender for Telegraph Stores," by noon on June 8.

Huddersfield.—Tenders are required for the supply and erection of a 92 unit direct-current dynamo and of a 3½-unit combined steam-engine and dynamo at Trafalgar Mills, Huddersfield, for Messrs. Learoyd Bros. and Co. Copies of specifications and general conditions can be obtained from Messrs. Shepherd and Watney, engineers, 71, Albion-street, Leeds, on receipt of a cheque for £1. 1s., which will be returned on receipt of a bona fide tender. Tenders, endorsed "Electric Lighting," must be addressed and delivered to Messrs. Learoyd Bros. and Co., Milnsbridge, Huddersfield, before noon on 19th inst.

Croydon.—The Corporation require tenders for the erection of a chimney shaft for the electric lighting station now being built in Factory-lane, Croydon, in accordance with drawings prepared by Prof. Kennedy, Old Queen-street, Westminster. The drawings and specification can be seen at the Borough Engineer's Office, 8, Katharine-street, Croydon, where also bills of quantities and form of tender can be obtained on payment of a deposit of £2. 2s., which will be returned to every person sending in a bona fide tender. Tenders to be sent to Mr. E. Mawdesley, town clerk, Municipal Offices, 8, Park-street, Croydon, by 11 a.m. on June 8.

Glasgow.—Tenders are invited by the Caledonian Railway Company for the supply of telegraph and electric appliances, etc., for 12 months from August 1, 1896. Specifications and forms of tender and any other necessary information may be obtained on and after June 1 from Mr. Jas Lorimer, superintendent of stores, Caledonian Railway, Charles-street, St. Rollox, Glasgow. Patterns may be inspected on and after June 1 from 9 a.m. till 5 p.m. at the Company's Stores, Charles-street, St. Rollox (Saturdays 9 a.m. till 1 p.m.). Tenders, endorsed "Tender for Stores," to be lodged with Mr. J. Blackburn, secretary, 302, Buchanan street, Glasgow, by June 15.

Leeds.—The City Council invite tenders for an electrical installation sufficient for the working by the overhead system of haulage, a double track of tramway seven miles long. The work will be divided into the following contracts: (1) poles for supporting trolley wire; (2) underground conduits and conductors; (3) trolley wire and attachments; (4) motorcars; (5) accumulators and switches; (6) steam engines; (7) dynamos, switchboards, and accessories. Tenders, endorsed with the number of the contract, must be sent in, addressed to the Town Clerk, Town Hall, Leeds, by June 20. Particulars, plans, forms of tender may be had (on payment of a deposit of £2 2s. for each contract, which will be returned on receipt of a bona fide tender) from the City Engineer, Municipal Buildings, Leeds; or from Dr. John Hopkinson, F.R.S., 5, Victoria-street, Westminster, S.W.

Shoreditch.—The Vestry invite tenders for the supply and fixing of insulated conduits, cables, switch and fuse boards, and all sundry fittings and materials for installing the electric light in their new dust destructor and electricity supply station, Coronet-street, Shoreditch. Specifications, with forms of tender, can be obtained from the consulting engineers Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of three guineas, which sum will be returned on receipt of a *bonâ fide* tender. Contractors whose tenders are accepted will be required to enter into a formal agreement, under seal, with sufficient sureties for the due fulfilment of their respective contracts. Trade union rates of wages and hours to be observed. Sealed tenders, endorsed "Electric Lighting—Tender for Wiring," to be sent by 4 p.m. on June 16 to Mr. H. Mansfield Robinson, clerk and solicitor, Town Hall, Old-street, E.C.

Kingston (Jamaica).—The Colonial Government invite electric tramway contractors willing to undertake the establishment and working of a system of rapid transit to send in applications for the grant of a license by the Governor in Privy Council under the Tramways Law, 1895. In all applications the principal questions to which attention should be directed are the following: (*a*) the amount of capital which the applicants are prepared to subscribe; (*b*) the system which it is proposed to establish; (*c*) the mileage of lines to be laid; (*d*) the fares to be charged; (*e*) the frequency of the service; (*f*) the length of the license required by applicants; (*g*) the guarantee which the applicants offer for the satisfactory performance on their part of any obligations devolving on them. Plans of the city of Kingston and part of the parish of St. Andrew, showing the routes on which the present tramway lines are laid, and copies of the law under which licenses are granted and of the rules made thereunder by the Governor in Privy Council, may be seen at the office of the Crown Agents for the Colonies, Downing-street, London, S.W. All applications must be delivered not later than July 31, 1896, in a sealed packet, marked on the outside "Application for Tramway License," to the clerk of the Privy Council, Kingston, Jamaica. Kingston has its principal means of transit at present supplied by the Jamaica Street Car Company by horse tramcars, the entire length of lines laid being about 12 miles. The concession granted by the Legislature of the island to the Jamaica Street Car Company will shortly expire.

Bucharest.—The result of the enquiry into the tender of contracts held on March 14-26, 1896, having led to no definite approval, notice is given that a fresh enquiry will be held on June 12-24, 1896, at 10 a.m. in the Town Hall, Bucharest, when sealed offers and tenders will be received for the lighting of the outlying zone of the town, by such a system as will not necessitate any canalisation, and which may be adjudged to be most advantageous of all the systems proposed, with a view to replacing the 3,265 petroleum lamps now lighting the streets and squares of the outlying districts of the town. The enquiry will take place in accordance with the conditions of contract established by the management of the Public Works Department and approved by the Town Council at its meeting held on January 24, 1896. Particulars of the conditions may be obtained at the offices of the Agence Havas, 96, Queen-street, Cheapside, London, between 11 a.m. and 4 p.m. The contract will be granted for a period of five years dating from the time of its approbation and acceptance by the Board of Enquiry, or for a longer period, according to the proposals and conditions of tenders submitted. Competitors must indicate in their tenders the points provided for in clause 6 of the conditions of contract respectively. Intending competitors are requested to attend on the day and at the hour above mentioned at the Town Hall, prepared with a deposit in 15,000fr. in cash or in Government stock, to be placed in the Public Pay Office, in order to be admitted to take part in the competition.

RESULTS OF TENDERS.

Colchester.—The Town Council have accepted the tender of the Electric Construction Company to establish an electric light installation at £10,675. They are applying to the Local Government Board for power to borrow £15,000 for this purpose.

BUSINESS NOTES.

Lambeth.—The final contract between the Vestry and Mr. Sax will be brought forward at the next meeting of the Vestry.

Eastern Telegraph Company.—The receipts for the month of May were £73,853, as against £68,382 for the corresponding period of 1895.

Crompton and Co.—Mr. John Trotter has been elected a director of Crompton and Co., Limited, in the place of Viscount Emlyn, resigned.

St. Helens.—The Local Government Board have sanctioned the application of the Corporation to borrow £10,000 for electric lighting purposes.

Rotherhithe.—The Electric Supply Corporation have given notice to the Vestry of their intention to lay mains in Rotherhithe New-road and Bush-road.

Eastern Extension Telegraph Company.—For the month of May the receipts show an increase of £5,536 as compared with the corresponding period of 1895.

Lincoln.—The Corporation are applying to the Board of Trade for a provisional order enabling them to put in force the provisions of the Electric Lighting Acts, 1882 and 1888.

India.—It is stated that the temples of India are to be lighted with electricity, the example having been set by the great shrine of Siva, at Kochicaddie, near Mutwal, in Ceylon.

South Shields.—In St. Paul's Presbyterian Church a new electric organ has been erected on the Hope-Jones system. The cost of the organ and fixing was a little over £800.

Tighnabruaich.—The lighting of this place with electric incandescent lamps is a success, and a beginning will shortly be made to introduce the electric light into private houses.

Bristol.—The electric cars on the city and Kingswood line of the Bristol Tramways and Carriage Company, Limited, carried during Whitsun week a total of 122,065 passengers.

Middlesex County Council.—The Council have resolved not to sanction the erection of telegraph poles from the Edmonton boundary to the Ponder's End Post Office by the General Post Office.

London, W.C.—The Strand Board of Works have given permission to the Exchange Telegraph Company to run an underground pipe across the Strand from the Outer Temple to the Law Courts.

Manchester Electrical Works, Limited.—This Company has been registered to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, etc. The capital is £1,000.

Osborne.—The National Telephone Company have been directed to connect Osborne House with the telephone exchange system now being established between the various towns in the Isle of Wight.

Lee (Kent).—At the meeting of the District Board of Works a suggestion as to connecting the Board's offices at Charlton with those at Lee, at a cost of about £20, was referred to the local committee.

Newbury.—The Earl of Carnarvon has recently had the electric light installed throughout Highclere Castle and stables, powerful engines for driving the machinery having been erected in the rear of the castle.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending May 31 amounted to £1,809, as compared with £1,146 in the corresponding week of the previous year, being an increase of £663.

Wrexham.—The Board of Trade having a few weeks ago revoked the Wrexham electric light and power order, the Lighting Committee of the Town Council are considering the advisability of the Council obtaining an order.

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Branksome.—On the recommendation of the Assessment Committee, the Poole Board of Guardians on Monday decided to sign a contract with Messrs. Castle and Castle for the revaluation of the electric light works at Bourne Valley.

Newhaven.—The Rural Council have decided to allow the Rottingdean roads to be opened for electric lighting purposes. Rottingdean parish adjoins Brighton, but this application was made by an electric lighting company.

Ealing.—At a meeting of the District Council Mr. Tidy asked when the accounts in connection with the electric lighting business would be ready. The Clerk replied that he hoped they would be ready by the next meeting of the Council.

Guernsey.—The High-street at Guernsey was temporarily closed on Wednesday whilst workmen removed all telephone wires, which, it is alleged, the National Telephone Company put up without the permission of the authorities, who object to lines crossing streets.

Telephonic Extension.—Norwich, Ipswich, Lowestoft, Yarmouth, and other important towns in the Eastern Counties, have been placed in direct telephonic communication with Bristol, Manchester, Birmingham, Sheffield, Leeds, Nottingham, Bradford, etc.

Electrical Copper Company, Limited.—This Company has been registered with a capital of £500,000 to acquire and work certain patents, patent rights, and inventions relating to the manufacture or treatment of copper and other metals by electrolysis.

Appointment Vacant.—The Leyton Urban District Council are prepared to receive applications for the post of resident engineer to the electric lighting installation now in course of construction. For particulars apply by letter to Mr. R. Vincent, clerk to the Council, Town Hall, Leyton, Essex.

Poplar, E.—The Board of Works have decided to apply to the Board of Trade for an extension of time in the matter of the Poplar electric lighting provisional order, and to approach the London County Council with a view of securing the supply of electricity for lighting the Blackwall Tunnel from the station of the Board.

City and South London Railway.—The returns for the week ended May 31 were £842, compared with £929 for the corresponding period of last year, being a decrease of £87. The total receipts for the half-year terminating as above were £20 535, compared with £20 533 in the same period of the preceding year, being an increase of £2.

Stockton.—The Corporation, being under an obligation to instal the electric light for public purposes or allow a private company to do so, are now applying to the Board of Trade for an extension of time, which would otherwise expire in August. At present the larger industrial companies and three or four tradespeople in the High-street have their own installations.

Peterborough.—Mr. Batten at the Town Council meeting objected to paying Dr. Fleming's account of £11. 14s. 6d. for attending the electric light enquiry unless and until Dr. Fleming made a report upon a scheme so that they could know what it was he proposed to do. He moved that the bill be not paid at present, but only two voted for the resolution, which was lost.

Tunbridge Wells.—At the request of the borough electrical engineer, the Watch Committee of the Town Council have agreed to instruct the chief constable to allow the police to turn off the arc lights and turn on the incandescent electric lights in the streets at midnight. The profit on the electric lighting amounts to £737 on the six months' working after allowing £50 to the rates for general establishment charges.

Worthing.—At the meeting of the Town Council the proceedings of the Electric Light Committee, who recommended that the town clerk should ascertain from the Board of Trade on what terms or conditions the Corporation might, if they so desired, obtain an extension of the period within which the works prescribed by their electric lighting provisional order are to be completed, were confirmed without discussion

Sale of Electric Plant.—Messrs. Percy Huddleston and Co announce in our advertisement columns the sale of the entire contents of the Acme and Immisch Electric Works, Ferdinand-street, Chalk Farm, N W. The sale, which comprises engines and boilers, dynamos and various meters and other electrical appliances, machine tools, office furniture, etc, will be held on the works, on June 16 next, at 10 for 11 o'clock.

The Edison Electric Illuminating Company of New York.—The gross earnings for April amount to 180 110dol, an increase of 16 700dol. as compared with the same month of last year, and net 90,584 lol., an increase of 12 899dol. For the four months ended April 30 the gross earnings were 777,670dol., an increase of 65,217dol as compared with the corresponding period of last year, and net 399,368dol., an increase of 56,786dol.

Manchester.—The special committee of the City Council appointed to consider the subject of the municipalisation of tramways report that, after full consideration, they are of opinion that it is desirable to allow the matter to remain over until nearer the termination of the first lease, which will expire on May 1, 1898, and that the Corporation should make application to Parliament for powers themselves to work the tramways of the city.

Pembroke.—A letter was read at the meeting of the Commissioners from the Board of Trade, dated May 19, informing the Commissioners that having received satisfactory reports from Colonel Yorke, R.E, and Major Cardew, R.E., the Board had certified the Dublin Southern District Tramways to be fit for public traffic, and had given a conditional consent to the use of electrical traction, limited for the present to a period of one month.

Birkenhead.—Mr. John Edwards enquired at the meeting of the Town Council when the Corporation electrical installation was likely to be completed. Alderman Deakin replied that there had been so many disappointments in this matter that he did not like to make any definite statement, but from a conversation he had with Mr. Shoolbred, the electrical engineer, he hoped that some portions of the district would be supplied with the service in the course of a few weeks.

Rochdale.—Sanction has been received from the Local Government Board to the contemplated borrowing of £500 for purposes of lighting the free library with electricity. The Library Committee have decided that the work should be proceeded with and that Messrs. Peers and Co., of Manchester, be appointed engineers in reference to the carrying out of the contract at a commission of 5 per cent. on the cost of the electric works, together with travelling expenses.

Hampstead.—At the Vestry meeting the Lighting Committee reported that they had given instructions for mains for the supply of electric current to private consumers to be laid in the following roads—viz., Greencroft gardens (from Finchley-road to Goldhurst-terrace) at an estimated cost of £125; Oakhill-park (portion west from Frognal), £28; Primrose Hill-road (from Fellows-road southward to parish boundary), £290; and Nutley terrace (Dalehamgardens), £52. The committee's action was approved.

Eccles.—The Town Hall and Electric Lighting Committee have accepted the offer of the National Telephone Company, Limited, to provide the telephonic communication required at the town hall, the cemetery, the fire station, the public baths, and the police station, for three years, at the annual rent of £43. 15s. Several large firms have indicated their desire to lay down installations, so that as soon as the Town Council can carry into effect their electric lighting order they will start with a very good demand. A Local Government Board enquiry has been held into the application by the Council to borrow £20,000 for carrying out the electric lighting scheme.

Sunderland.—The sub-committee having charge of the Corporation's electric light have decided to advise the reduction of the price of electric energy for motive purposes from 3½d per unit to 2½d. This is with a view of competing successfully with gas-engines as at 2½d. the cost will be about the same as that of gas. Some Wearside firms are already using electricity for running their machinery. The members also decided to recommend the Highways Committee to lay down additional feeders with a view to providing facilities for the ensuing winter.

Glasgow.—So far as can be judged, the present year's working of the electric lighting will result in a large surplus of revenue over expenditure. In view of this state of matters, the Electric Lighting Committee at their last meeting discussed a proposal to reduce the price to consumers, and it was suggested that the Brighton principle should be adopted. Under this a uniform charge is made for the first hour, after which a reduced scale comes into effect. The committee, however, decided to postpone a decision until the figures have been submitted.

Queen Anne's Mansions Lighting and Heating Company, Limited.—The trustees announce payment to the debenture-holders in cash for all the accrued interest, and a further cash payment for one moiety of the principal, the other moiety being satisfied by delivery of second debentures of the Queen Anne Residential Mansions and Hotel Company, Limited, bearing interest at 5¼ per cent. The old debentures, with all unpaid coupons attached, must be lodged at the office of the company, 251, Winchester House, three days before payment.

Dover.—The land wires for the new telephone cable between London and Paris being on the point of completion arrangements are being made to lay the cable across the English Channel at an early date. The cable will start on the English side from near Lydden Spout, about two miles westward of Dover, and between that town and Folkestone The cable will contain four wires, making two telephone circuits, which, with the existing cable, will provide four telephone services between the English and French capitals. The new cable will be used for simultaneous telegraphic and telephonic operations.

Douglas.—Special meetings of the Town Council have been held to take into consideration the question of assisting the Douglas Tramway Company to complete the upper Douglas tramway before the rush of the Manx visiting season The tramway company intended to have the tramway completed for the season, but difficulty after difficulty has had to be overcome. The Legislature has ordered that the busy thoroughfare of Prospect-hill shall be widened before the lines are laid along it. Unless, therefore, a great deal of property at present tenanted can be secured and cleared by the Town Council, the construction of the tramway cannot proceed this year without opening the principal streets in July and August.

Electric and General Investment Company, Limited.—The directors recommend a further dividend on the ordinary shares at the rate of 30 per cent. per annum for the six months ended May 31, making, with the interim dividend, 20 per cent. for the year, and they also recommend a dividend of £20 on each founders' share for the year. The trustees for the founders' share reserve fund propose to distribute to the holders of such shares a sum of £20 per share for the year out of the proceeds of investments sold and dividends received in respect of the founders' reserve fund, making a total distribution of £40 on each founders' share. The transfer books and register of members of the Company will be closed from the 5th to the 18th inst, both days inclusive, for the purpose of preparing the dividend warrants. The dividends, etc., are to be payable on the 19th inst.

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Dundee.—At a special meeting of the Gas and Finance Committee it was reported that in the electricity department there was a profit of £1,126 15s. 1d. Treasurer Ritchie reported that there was a surplus for the year of nearly £5,000. He moved that meter rents should be entirely abolished in both the gas and electric lighting departments. He also proposed that the electric light consumer should get the same discount as the gas consumer. An amendment was moved that the electric meter rents should be adjusted simply to recoup the Town Council for interest on sinking funds and original cost. Treasurer Ritchie's motion was adopted by a majority of one, the resolution with reference to the electric light being passed by his casting vote. A conference has taken place between a sub-committee of the Works Committee of the Town Council and a sub-committee of the Harbour Board on the question of controlling by electricity the public clocks in the city, numbering 10, and including the three at the harbour. The Harbour Trustees unanimously agreed to recommend that the harbour bear its proportion of the first cost of the apparatus and the annual cost of upkeep and of supplying the current.

New Issues.—Accles, Limited, has been formed, with a capital of £400,000, to acquire the business of general engineers and manufacturers of motorcars, etc., now carried on at the Holford Works, Perry Barr, Birmingham.—British Thomson-Houston, Limited, has been formed with a capital of £240,000 to enter into and carry into effect an agreement to be made with the British Thomson-Houston, Limited, to acquire, work, develop, turn to account, and deal with any tramways, railways, electric works, telegraphs, telephones, etc., and to carry on the business of electricians, mechanical and electrical engineers suppliers of electricity, and manufacturers of and dealers in electrical apparatus. The registered office is at 38, Parliament-street, E.C.—The London Electric Omnibus Company, Limited, has been formed with a capital of £250 000 to enter into and carry into effect an agreement with Radcliffe Ward and with the Solar Accumulator Company; to carry on the business of an electric omnibus company; to construct, lay down, establish and fix the necessary apparatus; and to carry on the business of electricians, mechanical and electrical engineers, suppliers of electricity, etc.

Exeter.—At the meeting of the City Council the Special Committee on Electric Lighting reported that it was necessary that the capacity of the works should be at once increased, and that the surveyor had stated that this increased power could be given either by steam or gas engines. A gas engine would be preferable for the purpose of giving an all night supply, and it was possible that it might also be found to be better to have the extra power entirely from gas-engines instead of fixing an additional boiler An additional alternator would also be necessary which might be driven either by a gas engine or by steam power and there must be an additional feed pump with steam and water connections. The committee recommended that they should be empowered to obtain prices of the two classes of machinery upon a guaranteed efficiency, and that upon receipt of the tenders they should recommend the acceptance of that considered most suitable. In moving the adoption of the report Mr. Domville said that as the Council took possession of the property on June 30, it was necessary for them to meet the increased demand for the light which would undoubtedly follow on their having committed themselves to a 24 hours' supply. Mr. Ham seconded, and the report was adopted.

Halifax—A few days ago a number of members of the Corporation, at the invitation of Alderman Woodhead, chairman of the Gas and Electric Lighting Committee, visited the electrical exhibition at Northgate Hall, and there partook of an electrically-cooked repast. A few brief speeches were afterwards delivered. Alderman Woodhead referred to the prejudices which had existed in Halifax with regard to electricity for even lighting purposes. He believed, however, that these were dying out. With regard to that day's experiment, they were now satisfied that they could cook by electricity, and to himself the result had been very agreeable. An hour before the meal the ovens used had never been tested at all. That, he thought, rendered the success of the experiment all the more satisfactory, and he understood that cooking by electricity could be accomplished at a fairly cheap rate. One advantage associated with it was that it could be carried on entirely without smell. Alderman Brook described the cooking they had experienced as perfect and mentioned that, as regarded the general use of electricity, the committee intended to supply the current continuously day and night. Councillor T. Greenwood, in adding his testimony, spoke of the wonderful developments being made in electricity. He was of opinion that, in many instances, it would supersede gas, and especially for small motors.

Cheltenham.—At the meeting of the Town Council the electrical engineer reported that within the next few months about £14,200 would be required to defray all actual expenditure contemplated and incurred up to the present time. The Electric Lighting Committee had decided that the whole extension from Manchester-street sub-station to High-street and Cambray sub-stations should be proceeded with at the estimated cost of £810, and that the extension to Lansdown-place sufficient to supply Trelawn be proceeded with at the estimated cost of £310. The borough engineer had submitted a design of a pillar for the incandescent electric lamps for street-lighting, which the committee had approved, and of which they had instructed the borough engineer to obtain tenders for a supply for as many as would be required for the Bath-road. An application from the electrical engineer for an increase of his salary was considered, and it was resolved to increase his salary to £260 per annum from June next, to increase each year by £20 up to £300 per annum, and that his department be independent of any other department, and that he alone be absolutely and directly responsible to the committee. Alderman Norman mentioned that the sanction of the Local Government Board had, after eight or nine months' delay, been received for loans amounting to £25,000 for extensions of the electric light undertaking.

Fife.—At the last meeting of the Telephone Committee of the County Council the chairman, Mr. H. V. Haig, said the first matter for consideration was the agreement (brought up by Mr. J Budge at a previous meeting) with the National Telephone Company, according to which they could put wires on the present poles. Mr. W. D. Patrick, clerk, stated that the agreement was made in 1885, and he read a letter from the Telephone Company, in which they admitted that additional wires could be erected by the Council on some of the poles. He thought they would find it difficult to impose the obligation, as the telephone system was now the property of the Post Office. Mr. Patrick stated that he had been looking into Acts as to the powers of the Post Office, and thought there was no doubt about the Council having the right to erect a telephone system. On the recommendation of Mr. Budge, Mr. Patrick was instructed to intimate to the Telephone Company that they had been too late in giving notice of the termination of the present agreement, and that it would continue for another year The Chairman stated that he had received a letter from Mr. L. Alwyn, Victoria street, London, in which that gentleman stated that he would be very glad to make an offer for the erection of a telephone system if the Council agreed to have one Mr. Alwyn assured him that it could be done at a very much cheaper rate than he had estimated, and he had in his employment Mr. Gardner, who had done all the work for the Telephone Company.

Liverpool—The sub-committee recently appointed by the City Council to examine the question of the lighting of the city, which has of late years been a matter of considerable local agitation, have presented an exhaustive report. The impression in the public mind has been that the charges for gas supplied by the Liverpool Gas Company are excessive in comparison with the charges in other cities, and there have been expressions of feeling that the works of the gas company should be acquired by the Corporation, and that the question of gas supply should become a matter of corporate undertaking. The sub-committee, after detailing their investigations, report that their conclusion is not in favour of entertaining the purchase of the gas company, but they recommend a closer oversight of the gas supply in the interests of consumers They suggest that the consumers should have a voice in the management, which could be effected by the appointment to the Board of the gas company of two or more members of the Corporation; but it seems quite open to question whether this would have the desired effect. At the meeting of the City Council, Alderman Walker, as an amendment to the general proceedings, proposed that a resolution approving of the plans and elevations of a building proposed to be erected by the Liverpool Electric Supply Company in Paradise-street, be referred back for further consideration. His principal objection was to the erection of two gateways facing Paradise-street, which he considered would be dangerous to the pedestrians. The town clerk read a memorial signed by residents and business men in the neighbourhood of Paradise-street, protesting against the erection of the proposed works. Mr. W. H. Watts seconded, but the amendment was lost by 57 votes to 18.

Leeds—The Yorkshire House to House Electricity Company recently made an offer to the Corporation to supply the current required for the proposed electric trams between Roundhay and Kirkstall The company, it appears, are willing to instal at their works in Whitehall-road the special plant required to deliver current at a suitable pressure, and to accept a contract for a short period to supply this current at 2·3d. per unit, assuming the quantity consumed to be about 300,000 units per annum. They explain that the price named is capable, under certain conditions, of very material reduction, as it is largely made up of the necessary provision for loss in the event of the specially provided plant being thrown on their hands at the end of the period. The price might, therefore, be greatly modified by extending the term of the contract, or by the consumption being larger than the company's rough estimate It is suggested, as an alternative, that the Corporation might provide the special plant and apparatus required, all of which would be easily portable and suitable for use when the permanent generating station was erected. In this way, also, a large reduction in the price could be effected, and the duration of the contract curtailed within very reasonable limits. The company urge that they are enabled by their large output to undertake the supply of energy at a price which is certainly as low as could be hoped for in works specially erected for the purpose, and they further point out that, by the acceptance of their offer, the Corporation would secure a minimum of risk and also be in a position, when extending their electric tramway system, to take advantage of any improvements in apparatus that might be effected in the meantime, or that might suggest themselves as the result of their experience.

Oldham.—At a special meeting of the Electric Lighting Committee the deputy town clerk read the statement of accounts of the Electric Lighting Committee for the year ended March 25 last, as follows: "The expenditure on capital account has been—engines and dynamos, £2,060. 18s 7d; batteries, £329. 17s. 7d; switchboard, £346. 13s 9d.; steam-pipes, etc, £155 16s 11d.; sundries, £37. 19s. 10d.; street mains, £3,358. 2s. 4d.—total, £6 289. 9s. The gross revenue for the year amounted to £3,847. 13s. 4d., and expenditure £1,577. 17s. 9d., the balance carried to net revenue account being £2 269. 15s. 7d. The interest on loans amounts to £813. 8s. 4d., and sinking fund account instalment to

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£608. 12s. 7d., the net profit for the year being £847. 14s. 8d. The balance brought forward from the previous year is £902 3s. 7d, making the amount to be carried forward to the credit of next year £1,749 18s. 3d. The price of energy supplied to all consumers has been 6d. per unit during the whole of the year. The minimum quarterly charge for energy was reduced from 10s. to 5s. from June 25 last, and the charges for meter rent were also reduced from that date. The committee have also decided that from and after March 25, 1896, the price for current used by private consumers in excess of two hours' daily average maximum demand should be reduced to 4½d. per unit, and for all current consumed by public street lamps to 4d. per unit. The amount of energy generated has been 179·966 units, of which 147·432 units have been sold, being increases over the previous year of 93·599 units and 78·434 units respectively. The number of lights supplied on March 25 last equivalent to 8 c.p. was 11,830, being an increase during the year of 4 890. The number of consumers added had been 58, and additional meters fixed 63. The number of consumers on March 25 was 113, and the total number of meters fixed 125 The maximum demand was on January 6, the load at the station being indicated at 251 kilowatts, as compared with the previous year of 135—an increase of 116. The greatest quantity supplied in 24 hours was on January 6, being 1,232 units, against last year 641—an increase of 601. An application for additional borrowing powers to meet the growing demand for the light has been acceded to by the Local Government Board to the extent of £15,000. Two additional engines and dynamos, each of 200 h.p. capacity, have been placed in the station, and the supply mains have been extended a distance of 1,187 yards. The total length of mains laid on March 25 was 5,763 yards. A sum of £500 received from the Gasworks Committee has been paid to the Sanitary Committee towards the cost of erecting a new chimney at the destructor works adjoining the supply station, and they in return have agreed to supply you with the surplus steam generated there, which it is expected will effect a material reduction in the cost of generation." The committee considered the report highly satisfactory, and it was accepted and ordered to be printed.

Edinburgh.—At the last meeting of the Corporation Mr. Mackenzie gave in a report by the Electric Light Committee, which recommended that as from May 15 the charge for electric energy be 5d. per unit, the charge for each public lamp £18 per annum, and that there be no meter rents. In doing so he stated that the electric lighting station was opened on April 11, 1895, with 48 private consumers, with lamps equivalent to 2,000 8-c.p. lamps connected. On May 15, 1896—after 13 months' working—there were 425 consumers with lamps equal to 54,360 of 8 c.p, and 247 public arc lamps equal to other 4,500—making a total on May 15, 1896, of equal to 58,860 8-c.p. lamps in all. The plant was put down for a total of 40,000 lamps connected, and it was thought that this would serve for two or three years before extensions would be required, but at Christmas every engine and boiler in the station were fully loaded, and the engineers had a very anxious time of it. For fear of a breakdown they had been obliged to borrow an engine from one of the London companies, the demand having come so suddenly that there was no time to get one of their own. Fortunately, no breakdown took place. In order to be able to cope with no doubt a very largely increasing demand next winter, five boilers, six low tension engines of 360 h.p. each, a number of high-tension machines, and other items of plant were on order and would be ready to run about the end of September, more than doubling the capacity of the station. The necessary extensions of mains were being carried out, and new consumers were being joined on daily. The prospects of the undertaking were therefore very promising from the engineering and demand point of view, and he was very glad to be able to say that the financial result of the past year and prospects of the current year were equally good. Commencing with a small load and having not only a full staff to keep up but heavy standing charges to meet, they were for 5½ months working at a loss, the turning point being about September 26. From that point to April 16 they made their income for the year. They were now again working at a loss, so that making their report for 13 months was a disadvantage, the loss from April 11 to May 15 having been about £200. The total income for the 13 months from private lighting was £13,220 18s. net, after allowing the discounts and for this they sold about 550,000 units. The total from public lighting was £3,604 and the units sold were about 320,006; total, 870,000 units sold during the 13 months, giving an income of £16,824. The total station expenses had been about £4,700, and this included carbons, trimming arc lamps, and upkeep of mains. The standing charges, interest, and contribution to sinking fund amounted to about £8,100, making altogether a total charge of about £12,800, thus leaving a balance of about £4,024. This was a most satisfactory state of affairs, and, as far as he knew, was a "record" for a first year's working. The Manchester installation—one of the most successful in the country—having a clear surplus the third year of its working of about £11,000), had for its first year a deficit of £210. The engineers estimated their income from May 15, 1896, to May 15, 1897, at £28,100 counted at present rates, and their total expenditure at £21,122, leaving a balance of £6,978. The Electric Lighting Committee thought that it would not only be fair to the consumers, but that it would be the best policy for the Corporation to reduce the charge for lighting from 6d. to 5d. per unit, the charge for motors from 3½d. to 3d., abolish meter rents altogether, and reduce the charge for public lighting from £20 to £18 per lamp. This would reduce the estimated income by about £4,100, but still leave an expected balance of £2,878. His own opinion was—and it was also the opinion of the engineers—that their balance would be very much larger, for he believed the effect of the reduction in price would be that a great many more consumers would come on, and that more current would be used per lamp. They had been very fortunate in their selection of Prof. Kennedy as their consulting engineer, a man of the very highest standing, and they had loyally followed his advice. They were also fortunate in their late resident engineer, Mr. Monkhouse, who worked with extraordinary energy. He had no doubt Mr. Newington would prove a most competent successor. The Corporation were also indebted to the other members of the staff, who had well supported their superiors.

Brighton.—An important enquiry has been held by Colonel John Ord Hasted, R.E., Local Government Board inspector, into the application of the Town Council for sanction to borrow £35,900 for the purposes of electric lighting within the borough. The Corporation were represented by Mr. W. P Boxall, instructed by the Corporation solicitor (Mr. H. Talbot), who with the town clerk (Mr. F. J. Tillstone) was also in attendance Mr. F. J. C. May (the borough engineer and surveyor), Mr. A. Wright (Corporation electrical engineer), and Mr. Stevens (borough accountant) were also present. Mr. Boxall said he thought some particulars as to the progress of the Corporation undertaking would be acceptable to the inspector On March 23, 1892, then, the number of consumers of electricity was 110; on the same date in 1893 it was 226; in 1894, 454; in 1895, 872; and in March of this year there were no fewer than 1,121 consumers in the borough. The quantity of electricity sold, as perhaps might have been expected, showed an equal, or even larger, proportionate increase. Taking the figures for the months of January and February in each year, they found that whereas in 1892 the total number of units sold was 22,000, in 1893 it was 44,000; in 1894, 78,000; in 1895, 148 000; and this year, 228,000. Exclusive of the cost of the coal, which was a matter of geographical consideration, some of the northern towns getting their supply almost at the pit's mouth, the cost of the production of electricity in Brighton was lower than in any other town in England. It was obvious, having regard to the increases in the business of the undertaking to which he had referred, that they must require an extension of their plant, more especially as the Corporation had resolved to supply electric lighting throughout the streets of the town, and a considerable portion of the loan now asked for would be expended in this direction. The loan also included £2,300 overspent on proposals of street-lighting previously sanctioned. With regard to the financial position of the borough, Mr. Boxall further submitted a statement prepared by the borough accountant, which showed the estimated total ratable value of property in the borough to be £756,507, the net value for the purposes of the general district rate being £734,868. The nominal amount which a penny rate would produce was £3,061, the net yield, after deducting the usual allowance, being £2,900. The present indebtedness of the Corporation under the Sanitary and Public Health Acts was £352,113. 5s. 10d., the indebtedness on the electric light account being £129,454. The assessable value of the town for two years was £1,469,737. Mr. Arthur Wright also gave particulars of the proposed extensions, observing as to the street-lighting that the idea was to have public electric lighting in every street where the Corporation mains were laid. With regard to the sum of £2,300, that was partly due to the cost of the new lamp standards. They had been estimated to cost the same as the standards on the King's-road, but the contractor would not supply them at the price, and instead of £16 each, they actually cost £35. Then, again, the Council decided to run 10 more arc lamps during the year than they had estimated for. The works to be done included extensions and new machinery, new mains, house services, etc. Mr. Boxall here interposed a statement of the profits of the undertaking. In 1894 there was a profit made of £4,400, of which £3,000 was placed to the reserve fund and £1,400 went in relief of rates Upon that the price of electricity was materially lowered, making a difference of £6,000 in the returns and yet in 1895 a profit of £1,150 was made. But for the reduction in price it would have been £7,500. The Inspector: What is your present charge? Mr. Wright: Sevenpence for the first hour and 3d. per unit afterwards. The average price we obtained last year was under 4¾d per unit, or lower than in any other town. Mr. May also explained the various plans which were put in, and the enquiry then terminated. The Works Committee have received a letter from the Solicitor's Department, General Post Office, with reference to the Council's refusal to grant permission for the erection of an overhead telegraph wire across Standford-road, and pointing out that the department could refer the difference under the Telegraph Act to a magistrate or county court judge with an appeal to the Railway Commissioners. The committee instructed the town clerk to reply stating that the Council consider telegraph and other wires carried over the streets in the borough are very objectionable; that they are willing, as on previous occasions, to grant the Postmaster-General facilities for carrying the wire underground across the street, as all the existing telegraph wires in the borough (with two or three exceptions) have been laid, and that the Council hope the Postmaster-General will not further press his application for permission to carry wires overhead in Brighton. The electrical engineer's recommendation to the Lighting Committee to run a supply main to the Prestonville district at an estimated cost of £1,600 has been approved, and the committee have decided that so soon as the mains are laid the street lamps along the line of route be lighted by incandescent electric lamps instead of gas An additional lamp is to be erected in Steine-lane, and the position of the existing lamp altered; an electricity main is also to be laid in Steine-lane, and the two public lamps to be erected in that street are to be lighted by electric incandescent lamps.

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PROVISIONAL PATENTS, 1896.

MAY 26.

11387. An improved electrical locking and unlocking railway signal apparatus. Adam Garson Horne, 154, St. Vincent-street, Glasgow.

11391. Improvements in cut-outs for electrical uses. John Clarkson Reynolds, Prince's-chambers, Wolverhampton. (Complete specification.)

11413. Improvements in pneumatic telephones. John Charles Chalmers, 62, St. Vincent-street, Glasgow.

11417. Improved means for electrically connecting the rails or sections of electric railways. Robert Calthrop Brown and Franklin Elias Huntress, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11419. Devices for electrically lighting the wick of oil lamps. Hugh Donald Fitzpatrick, 70, Wellington-street, Glasgow. (The Empire Self-Lighting Oil Lamp Company, United States.) (Complete specification.)

11421. Improvements in dynamos and electromotors and in the gearing of same. Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, London.

11429. Improvements in and connected with electric brakes for electrically-propelled vehicles. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London (William B. Potter, United States.) (Complete specification.)

11441. Improvements in electric arc lamps. Thomas Edgar Adams, 18, Buckingham-street, Strand, London. (Complete specification.)

11451. Improvements in apparatus for producing musical sounds by electricity. William Phillips Thompson, 322, High Holborn, London. (George Breed and Charles Addison Bragg, United States.) (Complete specification.)

11471. Improvements in arc lamps for alternating-current circuits. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Alexander Barnhill Fernald and John Henry Hubbell United States.) (Complete specification.)

11473. Improvements in electric railways or tramways. John Charles Love and John Earle Hodges, 45, Southampton-buildings, Chancery-lane, London.

MAY 27.

11481. Improvements in the driving of machinery, vehicles, boats, etc., by electric motors or other high-speed motors. Thomas Tomlinson, Ballywaltrim Cottage, Bray.

11517. Improvements in or relating to the application of electric light to carriage or other lamps. Herbert Alfred Bessemer, Bernard-street, Southampton.

11519. Improvements in or relating to induction coils, alternating-current motors, transformers, dynamos, and other machines depending upon the principle of electrical induction. Richard Joseph Crowley and Alfred Blandford Hutchings, ———.

11520. A new electrical signal of the signal-house at the railway station. Wilhelmine Magaretta Klees, 126, Carlton-vale, Maida Vale London.

11552. An improved means for switching current, applicable for electric motorcars operated by a mixed supply. Clemens Adam, 6, Lord-street, Liverpool. (Complete specification.)

11553. Improvements in the manufacture and production of filaments for incandescent electric lamps. Joseph Wilson Swan, 47, Lincoln's inn fields, London.

MAY 28

11617. An improved electric alarm for railway trains and other purposes. Henry Binko, 34, Leadenhall street, London.

11627. Improvements in secondary batteries. Ernest John Clubbe, Alfred William Southey, and the Electric Motive Power Company, Limited, 55, Chancery-lane, London.

11647. Improvements relating to electric couplings. Emma Theodora (Lady Forbes), 45, Southampton-buildings, Chancery-lane, London.

MAY 29.

11710. An improved electrical method of joining metallic and other tubes, pipes, bars, and the like. William Leannard Poole, Alfred Stone, and Alexander St. Vincent Turquand, 168, Fleet-street, London.

11724. Improvements in the manufacture of electrical hot-plates and other apparatus designed for electrical production of heat. Albert Ernest Woodhouse, 7, Staple-inn, London.

11730. An improved apparatus for producing galvanic or electrolytic depositions. Williams Phillipe Thompson, 6, Lord-street, Liverpool. (The Elektra Galvanoplastische Anstalt, H Teith, and A. Floeck, Germany.)

11732. An improved plate for storage batteries. Franz Grünwald, 6, Lord-street, Liverpool.

MAY 30.

11813. Improvements in or relating to electric cables. William Arthur Price, 55, Chancery-lane, London.

11779. Electric arc lamp. James Grieve Lorrain, Norfolk House, Norfolk-street, London. (James McLaughlin, United States.)

11783. Improvements in electric railways. Henry Harris Lake, 45, Southampton-buildings. Chancery-lane, London. (Galilec Ferraris and Ricardo Arno, Italy.)

11800 Improvements in coin-freed electric meters for the measurement of electricity. Jacob Atherton, George Knight, and George Ellis, 70, Palace-chambers, Westminster.

11801. Improvements in sockets or holders for electric incandescent lamps. J. Katzenstein, 23, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1893.

13066 * Incandescent lamps. Boult. (Steuer.) (Amended specification.)

1895.

9144. Electric soldering apparatus Binswanger and Ball.

9146. Arc lamps. H. and R. Niewerth.

10302. Laying submarine electric cables. Snell.

12187. Telephonic apparatus. Holden

12414 Electrically lighting vehicles. Niblett.

12683. Telephone transmitters. Berdell.

13014. Dynamos and electric motors. New and Mayne.

20923 Electric annunciators. Thompson. (Higgins.)

1896.

1344. Securing electric insulators, hooks, etc., to walls, girders, etc. Beaujean.

3091. Accumulator batteries. Linde.

4806. Magnetic separators. Weatherill.

5389. Autographic telegraph apparatus Jackson. (Etheridge.)

6048. Controllers for electric motors Devonshire. (Potter.)

6208. Electric switches. Ballance and Hewson.

6487. Controllers for electric motors. Devonshire. (Priest.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6¼
Brush Company, Ordinary	3	1⅞-1⅞
——— Non. Cum., 6 per cent. Pref.	2	1⅜-1⅝
——— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	8¼-8⅜
Chelsea Electricity Company	5	7⅛-8
——— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14½-15⅝
——— 6 per cent. Cumulative Pref.	10	16½-17
——— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	42-44
——— 4 per cent. Debenture Stock	100	135-137
——— 5 per cent. Pref. Shares	10	5-15⅛
County of London and Brush Provincial Co., Ordinary	10	8¼-9¼
——— 6 per cent. Cum. Pref.	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1⅛-1⅜
——— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	1-1⅛
——— 7 per cent. Cumulative Pref.	2	2⅛ 3
Elmore's Copper Depositing	2	1⅜
Elmore's Wire Company	2	2⅜
W. T. Henley's Telegraph Works, Ordinary	10	16-17
——— 7 per cent. Preference	10	17-18
——— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	3⅜-3⅝
——— 7 per cent. Preference	5	8-8¼
India Rubber and Gutta Percha Works	10	23-24
——— 4½ per cent. Debentures	100	106-107
Isle of Man Electric Trams, Ordinary	1	1⅜-1⅝
——— 6 per cent. Preference	1	1⅜-1⅝
Kensington and Knightsbridge Ordinary	5	9-9½
——— 6 per cent. Pref.	5	7⅛-8
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	14-14½
——— 5 per cent. Pref.	10	17½-17⅞
——— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	1-1⅛
Metropolitan Electric Supply	10	13½-14½
——— 4½ per cent. First Mortgage Debenture Stock	100	120-122
National Telephone, Ordinary	5	7⅜ 7⅛
——— 6 per cent. Cum. First Pref.	10	16-18
——— 6 per cent. Cum. Second Pref.	10	16½-17½
——— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6⅞
——— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	9-9½
Oriental, Limited, £1 shares	1	1½-2 xd
——— £5 Shares	5	8¼-8⅜ xd
——— £4½ shares	4½	7¼-7⅜ xd
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4⅜-5⅛
St. James's and Pall Mall, Ordinary	5	10½-11⅛
——— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	38-41
——— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	6	8-8½
Westminster Electric Supply, Ordinary	5	9½-10
Yorkshire House-to-House	5	7⅛-8

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NOTES.

Run and Read.—This is neither a souvenir nor a premature number, nor an attempt to stop the issue of a report in our contemporaries; it is merely a sample of our usual enterprise. "Eclipse first—and the rest nowhere."

Personal.—Mr. R. P. Wilson, of 3, Princes-mansions, Victoria-street, S.W., has severed his connection with the British Thomson-Houston, Limited, and proposes to continue the consulting work in which he has been engaged for some years.

Colliery Traction.—It is stated that the electric locomotives used in the Marles Colliery in the Pas-de-Calais weigh three tons each and draw three cars, holding each 15 tons of coal, at the rate of 10 miles an hour. They replace 30 horses.

Long-Distance Power Transmission.—The Lowell (Michigan) and Grand Rapids power-transmission line is 18 miles long. The pressure is as high as 10,000 volts (alternating), and the power is derived from turbines on the Flat River. About 200 kilowatts are transmitted.

North-East Coast Engineers.—We have received volume xii. of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders, covering the meetings from January to March, 1896, and containing important papers on the vibration of steam-engines.

Manila Rope.—We have received from the C. W. Hunt Company, of Broadway, New York, a well-got-up descriptive account of their manila rope, its manufacture, and the method of using it. In an appendix there are useful tables and formulæ relating to rope driving, and a reprint of Mr. Hunt's paper on that subject read before the American Society of Mechanical Engineers.

The Coming Week.—This evening (Friday) there is a conversazione at the Central Technical College, Exhibition-road, South Kensington, at 8 p.m. On Saturday the Institution of Electrical Engineers have a students' visit to the Bankside station of the City of London Company at 7.30 p.m. The Chemical Society meets as usual on Thursday, and next Friday Mr. Martin gives the "discourse" on Niagara at the Royal Institution.

Meteorological Society.—At a meeting of this society at the Institution of Civil Engineers at Great George-street, Westminster, on 17th inst., at 7.30 p.m., the following papers will be read: "Arctic Hail and Thunderstorms," by Henry Harries, F.R.Met.Soc.; "Climatology of Valencia Island, co. Kerry," by J. E. Cullum, F.R.Met.Soc.; and, if possible, also "The Winter Climate of Egypt, based on Results from Self-Recording Instruments, 1893-6," by H. E. Leigh Canney, M.D.

Rontgen Radiations.—Dr. John Macintyre has been trying to polarise Röntgen radiations by means of tourmaline, and cannot get any evidence of a polarising effect. He used a coil giving a 6in. spark, tourmalines 2mm. thick, and adjusted his vacuum to the point at which a maximum fluorescence was obtained. Prof. Haga, of Groningen, finds that the new radiations diminish the electrical resistance of selenium. With the particular tube he used the effect was about half that of full daylight.

Rainmaking.—The drought which prevailed up to last week has caused Mr. S. F. Walker to write to a Cardiff local paper to suggest that something may be done in the way of producing rain by electrical means. Mr. Walker's idea is practically embodied in the following question: "Why should we not cause an aggregation of the particles of moisture about the particles of dust, followed by deposit in the form of rain, by producing an artificial disturbance of the electrical conditions present in the atmosphere?" It is rather hard on the provincial editor to ask him such a question as that.

Electricity on the Stage.—In a brief article on the use of the electric light for the production of stage effects *L'Energie Electrique* says that nothing hitherto produced in this way can compare with what was done at the Drury Lane pantomime last winter. By the lavish use of incandescent lamps "the effect obtained was absolutely marvellous." It may be worth notice that our contemporary reproduces with suitable acknowledgement the illustrations of Cinderella's car and the transformation scene which appeared at the time in the *Electrical Engineer*.

New Lamps.—According to the New York *Electrical Review*, Mr. Tesla has been suffering from influenza. Nevertheless, he has been interviewed on the subject of Mr. Edison's new lamp. All that could be got out of him, however, was that "he had the utmost faith in the genius of Mr. Edison." From the discussion on Mr. Macfarlane Moore's paper at the American Institute of Electrical Engineers, it would appear that, so far as measurements have been made, the general opinion is that Mr. Moore's long Geissler tube lamps are not so efficient as the ordinary carbon filament.

Society of Engineers.—A visit was made by a large party of the members of the Society of Engineers on Tuesday to the Surrey Commercial Docks, Rotherhithe. Among those present were Mr. W. Worby Beaumont vice-president; Mr. Henry Adams, Mr. Joseph Bernays, Mr. A. T. Walmisley, and Mr. J. W. Wilson, jun., past-presidents; Mr. George Burt and Mr. Percy Griffith, members of council; Mr. Perry F. Nursey, hon. secretary and treasurer; Messrs. D. B. Butler, W. G. Cooke, H. Conradi, S. N. Glass, B. D. Kershaw, R. St. George Moore, H. Stanton, and Mr. G. A. Pryce Cuxson, secretary.

National Telephone Company.—This company have had their wires cut in Ludlow by the Ludlow Corporation's workmen, in consequence of their refusing to enter into an agreement with the Town Council in reference to fixing their lines. The owners of the other wires paid the required sum asked by the Corporation. They have also been cast in damages to the extent of £36, in the Dublin Courts, owing to one of their linesmen when engaged in making repairs dropping a saw on the head of a schoolboy, named Tuohy, who was passing underneath their poles at Killiney. But that is a thing that might happen to anyone.

New F.R.S.'s.—At the annual meeting of the Royal Society for the election of Fellows held last week, the following were elected into the society: Lieut.-Colonel Sir George Sydenham Clarke, R.E., Mr. J. Norman Collie, Ph.D., Mr. Arthur Matthew Weld Downing, D.Sc., Mr. Francis Elgar, LL.D., Prof. Andrew Gray, Mr. George Jennings Hinde, Ph.D., Prof. Henry Alexander Miers, Mr. Frederick Walker Mott, M.D., Mr. John Murray, Ph.D., Prof. Karl Pearson, the Rev. Thomas Roscoe Rede Stebbing, Prof. Charles Stewart, M.R.C.S., Mr. William E. Wilson, Mr. Horace Bolingbroke Woodward, F.G.S., and Mr. William Palmer Wynne, D.Sc.

New York Electrical Exposition.—The New York journal *Electricity* says the electrical exhibition was designed on popular rather than technical lines, and "from the popular or public point of view the exposition has been an instant success. The electrician, to whom many if not all devices are already known, may find less of interest than will the layman, but this is no fault of the exposition—the members of every trade or profession know more of its progress and development than do the outsiders. The exposition was designed on popular rather than technical lines, otherwise the interest which

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it has aroused would not have been so general, neither would it be possible to sustain it for so long a period as four weeks."

The Post Office Committee.—Mr. W. H. Preece has been giving evidence before the Inter-Departmental Committee on Post Office Establishments. Mr. Preece was examined by Lord Tweedmouth, and said that all telegraphists had to possess a knowledge of electricity as applied to telegraphy and telephony. Increased knowledge tended to the efficiency of the service, and whatever tended to increase the efficiency of the service meant increased business. The Department did all they could to promote education among the men. As to promotion, there was nothing to prevent a linesman from becoming an engineer-in-chief. In answer to Mr. Spencer Walpole, Mr. Preece said there was no truth in the statement that men were promoted because they happened to be sons of the heads of departments.

The London University Question.—Dr. Collins has replied in the *Times* to Dr. Silvanus Thompson's letter. He says, and quotes Sir John Lubbock in support of it, that Convocation ought be consulted on the reorganisation scheme. But "under the present charter no machinery is provided for the expression of the opinions of all members of Convocation on any matter except the election of a Fellow." "Any canvass of the whole of Convocation on the question of reconstitution of the university must, therefore, be unofficial, and that which was made by Mr. Bompas and Dr. Napier was, of course, unofficial, but I certainly understood that the issue of the circulars and postcards was purposely delayed so that they might be first submitted to the Lord President of the Council and the member for the university, for any suggestions or alterations they might desire to make."

Gas and Air Mixtures.—A printed summary has been forwarded us of a lecture delivered by Prof. Frank Clowes on Tuesday before the Gas Institute on the subject of explosive mixtures of combustible gases with air and the methods of detecting them. Besides the actual explosive mixture, the products of explosion or incomplete combustion are considered. It has been long known that though immersion in an atmosphere of carbonic acid produced instant death, that gas was by no means fatal if a reasonable proportion of oxygen is present, while carbonic oxide, which forms a large proportion of producer and Dowson gases, acts like a poison, so that very small quantities of it are fatal. A curious fact brought out is that a mouse is much more sensitive to the action of this gas than the human subject, and that if one is carried in a wire cage where the presence of carbonic oxide is suspected, warning will be given sufficiently quickly to allow of retreat.

The German Electrical Engineers.—The programme and arrangements for the fourth annual meeting of the Verband Deutscher Elektrotechniker at Berlin next week are, except so far as concerns some of the subjects to be discussed, given in the *Elektrotechnische Zeitschrift* for June 4. A council meeting is to take place at the Architektenhaus at 10 o'clock on Wednesday, June 17. In the evening there is a reception at the Reichshalle, Leipsigstrasse. On Thursday, at 10 o'clock, the presidential address is delivered at the Architektenhaus. After this the secretary's and treasurer's reports are to be taken and the committee's reports presented, including one on safety rules, and the announcement of the award of the prize for non-interchangeable fuses. The committees for next year will then be appointed. In the evening there is a dinner at the Kaiserhof. On Friday there will be visits to various works and to the exhibition. On Saturday there is again a meeting at the Architektenhaus, when the officers and council will be appointed and the arrangements for the next year settled.

The Greenwich Observatory.—The annual visitation of the Royal Observatory took place on Saturday afternoon, when the Astronomer Royal, Mr. W. H. M. Christie, presented his report of a year's work to the Board of Visitors. From this it appears that the usual magnetic observations have been made during the year, the mean declination for 1895 being 16° 57·4′ west. Uncertainty attaches to the results of the mean horizontal force owing to the permanent effect of the iron in the new altazimuth pavilion, and the results of the magnetic dip are affected to the extent of about 3′ or 4′ for the same reason. An independent determination at a place sufficiently removed from this building is urgently required, but the question has been deferred pending the settlement of the site for the new magnetic building. During the year there were no days of great magnetic disturbance. The spot activity of the sun has steadily declined from the date of the last report, and on five occasions during the months of April and May, 1896, the sun was entirely free from spots—a state of affairs which last took place on March 28, 1891.

Institution of Civil Engineers.—The tabular statement of transfers, elections, deaths, and resignations during the year shows an effective increase of 109 on the previous total of 5,921, while the number of students was 877 as against 816 at the corresponding period of last year. The gross numbers on the books on March 31 in 1895 and 1896 were 6,737 and 6,907 respectively. At the annual general meeting, on Tuesday, the council for the session 1896-97 was duly elected, when several members were placed on the governing body as representative of the profession outside the United Kingdom. The full list of this new council is: President, Mr. John Wolfe Barry, F.R.S.; vice-presidents, Mr. W. H. Preece, F.R.S., Sir Douglas Fox, Mr. James Mansergh and Mr. William Anderson, D.C.L., F.R.S.; other members: Mr. A. R. Binnie, Mr. Henry Deane, Mr. W. R. Galbraith, Mr. George Graham, Mr. J. H. Greathead, Mr. J. C. Hawkshaw, Mr. Charles Hawksley, Mr. John Hopkinson, jun., D.Sc., F.R.S., Mr. A. B. W. Kennedy, LL.D., F.R.S., Mr. John Kennedy, Mr. G. Fosbery Lyster, Sir Guildford L. Molesworth, Sir Andrew Noble, F.R.S., Mr. William Shelford, Mr. B. B. Stoney, LL.D., F.R.S., Mr. F. W. Webb, Sir W. H. White, F.R.S., and Sir E. Leader Williams. Of these gentlemen Mr. Henry Deane represents Australia, and Mr. John Kennedy, Canada.

Trunk-Line Telephones.—We are constantly hearing of the progress made in connecting up the larger towns in this country by trunk-line telephones. Yet it does not quite seem that all is for the best in the best of all possible services. Anyhow, there are clients who are still dissatisfied. If the following is an example of the sort of thing that goes on, this is perhaps explicable. Messrs. Mellors, Basden, and Mellors, of Nottingham, write to the *Times* to say: "We yesterday had occasion to telephone to Birmingham. After conversing for about one minute the girl at the post office telephoned, 'Time up.' We thereupon asked for a second three minutes, stating that we would pay for it. The answer was, 'You must ring off, and telephone to the National Telephone Company again for them to ask us to put you in communication. This meant a further half-hour in getting through by the exchange between here and Birmingham. We to-day wanted to converse with Mansfield, and after one minute's conversation, owing to one of the principals having to be called to the telephone, the Post Office again informed us

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'time was up,' and they could not allow us to continue the conversation, but we must ring up again. On complaining to the National Telephone Company, they inform us that from June 1 the Post Office authorities have taken over the trunk lines. We have never had this difficulty before, and it practically renders the telephone to long distances almost useless for business purposes." Of course, a customer could not be allowed to monopolise the wires for an indefinite time, whatever he was willing to pay ; but if a speaker has to wait half an hour to send his final half-dozen words over the wire, he will probably prefer to write or telegraph.

The Royal Society.—The second reception of this society for the present season was held on Wednesday night at Burlington House, when a large assemblage of guests were received by Sir Joseph Lister, president, and Lady Evans, wife of the treasurer. There was a very large and interesting collection of scientific exhibits. Mr. Herbert Jackson demonstrated the use of phosphorescent materials in rendering Röntgen rays visible, and Dr. John Macintyre exhibited three series of photographs taken by the rays, including photographs of soft tissues, a series including neck, tongue, larynx, heart (normal and abnormal), diaphragm, muscles, etc. Prof. Silvanus Thompson had also some very beautiful experiments and demonstrations with these rays, including the production of electric dust shadows. One of the finest exhibits was that by Mr. R. L. Mond, consisting of the apparatus intended for the Davy-Faraday Research Laboratory at the Royal Institution. Messrs. Siemens Bros. and Co. showed an historically interesting series of apparatus in connection with electric discharges in vacuum. One of these was a fac simile of Dr. William Watson's vacuum tube of 1751—the first apparatus ever constructed for experiments on the electric discharge in a vacuum. Prof. Dewar showed a variety of striking experiments with liquid air, including solid alcohol, frozen soap bubble, distilling mercury and phosphorus, the diamond burning in liquid oxygen, ignition by means of a lens of liquid air. The Lords of the Committee of Council on Education have arranged for the public exhibition in the western galleries of the Science Museum at South Kensington of a number of the objects shown at the soirée. The exhibition will remain open to the public for about a fortnight.

Theories of Magnetism.—One of the interesting points in connection with the recent investigations into the effects of very low temperatures on magnetic properties is the possibility of their throwing some light on what really takes place when iron is magnetised. In his discourse last Friday at the Royal Institution, Dr. Fleming stated that the decreased permeability of soft iron at the temperature of liquid air was explicable on the magnetic-molecule theory, since the cooling of the iron, with its consequent contraction, brought the molecules closer together, and their mutual attractions being thus increased it naturally required a greater magnetising force to collineate them. But the increased permeability of hard iron at the same temperature was more difficult to explain on any accepted theory of magnetism. It is to be presumed, however, that Dr. Fleming's difficulty lay mainly in making the matter intelligible to all his audience within the narrow limits of the minutes to spare at the end of a discourse. For assuming that in soft iron each molecular magnet is comparatively free to turn, the condition of hard iron will correspond to the formation of a quantity of highly stable groups of molecular magnets which have to be broken up in order to secure collineation. But when it is remembered that, though little enough is really known about molecules, the one thing certain about them is that they contain a good deal of motion, it is seen that the equilibrium must be one of a stable system of moving bodies. It is not difficult, therefore, to conceive that the subtraction of a large percentage of the molecular motion consequent on excessive cooling might seriously impair the stability of some of the groups, or, what is the same thing, increase the permeability. What, however, is really wanted for the theory in question is some explanation of how and why the iron molecule can act like a tiny permanent magnet.

From the Gasworks Point of View.—It is always wholesome to see ourselves as others see us, and therefore the presidential address of Mr. W. R. Chester delivered at the thirty-third annual general meeting of the Incorporated Gas Institute held on Tuesday at the rooms of the Society of Arts, Adelphi, is worth some few lines notice. Mr. Chester dwelt on the rivalry between the electric light and the gas industry, and urged that in the race for public favour the former was for many years to come likely to enjoy the equivocal complimentary title of "the light of the future," which no gas engineer would grudge it. The latest returns to the Board of Trade showed that £69,423,431 had been invested in the authorised gas undertakings of the country, which was an increase of £1,750,000 on the previous year. The coal carbonised had been 11,319,301 tons — an increase of 300,000 tons on the previous year. The gas sold had been 105,160,990,000 cubic feet, an increase of 3,274,000,000 cubic feet on the previous year ; while the total receipts amount to £19,408,265, and the cost of production to £13,791,520, thus leaving a margin of £5,616,745 gross profit, sufficient to pay 8·1 per cent. on the total capital employed. As to the electric light, it appeared that the total capital invested in the authorised undertakings of the country was £6,470,942, the output of electricity being 24,145,719 Board of Trade units, the receipts £692,734, and the expenditure to £377,691—leaving a balance of £315,043 as gross profit, which was equal to 4·87 per cent. on the capital employed. The total output of electricity for the whole country was little more than one-half the normal progressive increase in the consumption of gas for one year, or, to put it in another way, nearly two additional installations of electric light plant of equal magnitude to the existing ones would have to be put down each year before the normal annual growth in the consumption of gas would be arrested. All this no doubt sounds extremely comforting to the gas engineer. It is always a difficult piece of business to turn out people who are in possession of the field, and, apart from that point, it would have been very much more to the purpose if Mr. Chester had given us some statistics as to the profits and prices of gas companies in the years when gas lighting was yet a young industry.

The Fastnet Lighthouse.—In the fourth report of the Royal Commission on communication with lighthouses details are given of the method of communicating with the Fastnet lighthouse, which is situated about seven miles off the south-west corner of Ireland. The precipitous rock on which the lighthouse is built is exposed to the full force of the Atlantic seas, and is unapproachable except in calm weather. In 1885 electrical communication by a continuous cable was established with the lighthouse at the instance of the committee of Lloyds, who had received permission to use it as a signal station, but the difficulty and expense of maintaining the connection were so great that it was abandoned at the end of 18 months, after several lengthy interruptions in communication had occurred. Having regard to the difficulty of maintaining electrical communication with the Fastnet by means of a continuous cable, the Commissioners have now tried a non-

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continuous system since July 18, 1895. A submarine cable of the ordinary type, 7·0288 knots in length, is laid from a small bay called Galley Cove, towards the lighthouse; the sea end is spliced to 17 fathoms of heavy copper wire, insulated with indiarubber and protected by lignum vitæ rings; and this wire terminates in a copper mushroom anchor weighing 4½cwt., which is submerged in 11 fathoms (low water) at a distance of about 60ft. from the Fastnet. The shore end is connected by a subterranean cable with the post office at Crookhaven, from which is laid another cable 200 yards long, terminating in a copper centipede anchor, sunk in about two fathoms of water in the haven on the further or north-east side of the promontory on which the post office stands. At the Fastnet two short copper conductors, connected with the instrument in the lighthouse, are bolted to the sides of the rock, one on the north, or land, side, and one on the south side, each terminating under water in a copper centipede anchor. This is the present arrangement, but one of the conductors having been broken by the action of the sea, it is proposed to protect the exposed parts of both conductors by passing them through holes which will be drilled in the rock for the purpose. The mushroom anchor near the rock and the centipede anchor in the haven form the earth plates of the line, the post office at Crookhaven with its batteries and instruments being intermediate. The circuit is completed by the sea, but part of the current passing through the circuit is picked up by the nearest copper conductor on the rock and actuates the telegraph instrument placed in the lighthouse. It then passes through the other copper conductor into the sea. In the reverse direction part of the current sent from the lighthouse is picked up by the mushroom anchor, and passing along the main cable, actuates the telegraph instrument in the post office at Crookhaven. The instruments used both at the lighthouse and at the post office are a double current speaking-key and a dead-beat d'Arsonval reflecting galvanometer, and the signals are those of the Morse code. Except for a short period when one of the conductors on the rock was broken, telegraphic communication has been maintained throughout the winter, but it has not been possible to apply the ordinary arrangement for calling attention by means of a bell, and it has therefore been necessary for the operators to go to the instruments at stated intervals to ascertain whether there was anything to communicate. Now that the winter has passed, and it has again become possible to work on the rock, no time is to be lost in fitting a call-bell, which will be worked by a specially devised relay.

Communication with Lighthouses.—Some time ago we gave the conclusions arrived at by the Royal Commissioners on electrical communication with lighthouses and light-vessels, which was to the effect that they could not yet make a final report, as though communication with lighthouses was fairly satisfactory, the serious difficulties which continue to be experienced in maintaining electrical communication with light-vessels on the system now employed necessitate further experiments being made in this direction. The Commissioners have, however, issued a fourth interim report, from which it appears that while at the time of the third report electrical communication had been established with four light-vessels, Goodwin (North Sand Head), Kentish Knock, Shipwash, and Hasborough, one pile lighthouse (Gunfleet), two lighthouses on small islands or isolated rocks (Lundy and Tuskar), and 38 shore lighthouses, to this list may now be added the Fastnet and Caldy lighthouses, the Formby light-vessel, Maplin pile lighthouse, and Bidston and Llanddwyn shore lighthouses. There are, therefore, at present five light-vessels, six island, pile, or rock lighthouses, and 40 shore lighthouses around the coasts of the United Kingdom which have been placed in electrical communication with the general telegraph system of the country at the national charge. The Mersey Docks and Harbour Board have also connected for their own purposes five of the lighthouses under their control, and one or two other shore lighthouses have been connected by similar bodies in the United Kingdom, apart from any recommendations from the Commissioners. Details are given as to the troubles experienced with the lightships, the interruptions experienced being apparently due to the impossibility of preventing the electric cable chafing against the mooring cables or the ship itself, and in one case at least there was a breakage due to the ship riding to the electric cable. The Commissioners therefore propose to experiment with a non-continuous system, under which the cable running from the shore is laid in a circle on the bottom of the sea immediately under the light-vessel, the circle having such an area that the vessel will always be within the circumference of it. Round the deck of the light-vessel a number of turns of insulated wire are coiled, which are in connection with a telephonic receiver on board the ship. An intermittent vibratory current is sent through the cable, and is made and interrupted by a Morse key. The vibrations act by induction on the coils of wire on the light-vessel and produce buzzing sounds in the telephone, which, being intermitted by the Morse key, are read as in the ordinary Morse code. By means of a special arrangement a call-bell can be rung. In the same way messages can be sent from the light-vessel to the shore. This system has not yet been subjected to a practical test at a lightship, but the Commissioners regard it as offering greater chances of success than any of the other inventions of the same nature, and meanwhile defer recommending the establishment of electrical communication with any further light stations, awaiting the result of the experiments which are about to be made. In an appendix details are given of what has been done in the Colonies and abroad. With the exception of Newfoundland it may be said that in the Colonies there is, in general, electrical communication to lighthouses on the mainland, but not to outlying lights or lightships, but in Queensland the half-dozen island lights are connected. In India there is hardly any communication. The practice of foreign countries differs widely. In Denmark, which the Commissioners visited, there is a very perfect system. In Germany, Holland, and Russia there is a good amount of connection, and in most other countries there is very little; in France none whatever, and the United States are still discussing the question, but have about half-a-dozen lights connected. None of these countries have any connection with lightships.

The Pacific Cable Conference.—The first meeting of the committee appointed to consider a scheme for establishing direct cable communication between England and Australia, *viâ* the Dominion of Canada, has been held at the Colonial Office. The Imperial delegates were Lord Selborne, Under Secretary of State for the Colonies, and Mr. G. H. Murray, C.B., a principal clerk at the Treasury; the Canadian Commissioners were Sir Donald Smith and Sir Mackenzie Bowell, with whom was Mr. Sandford Fleming, C.E., who is acting as their technical adviser; and the Australian representatives were Sir Saul Samuel and Mr. Duncan Gillies. The proceedings were private. The *Times* has devoted a column and a half to the subject. And after giving an account of the origin and progress of the inter-colonial cable scheme, the present state of things is summed up as follows: "Early in June of last year the agent of the (French) com

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pany owning the cable from Queensland to New Caledonia entered into negotiations in Honolulu for landing privileges and for a subsidy for laying a cable from San Francisco to Honolulu. Not long afterwards orders were given for the manufacture of a cable to be laid between San Francisco and Honolulu, and in September it was known that the Hawaiian Government had concluded a contract under which a company could be formed for laying a cable from San Francisco to the Hawaiian Islands. The company will be subsidised and will have the exclusive right to lay cables within the Hawaiian Republic. The cable is to be begun not later than May, 1897, and to be completed in November of 1898. Under the contract no cable can be laid from Canada to the Hawaiian Islands for 20 years, thus forcing all Canadian business to pass through the United States, and barring the British groups of colonies from any cable connection *vid* the Hawaiian Islands except through the American company. The contract places the control of the company under the Government of the United States. Thus, as the position stands with regard to the construction of a Pacific cable under foreign control, it is provided that by the end of the year 1898 an American section from San Francisco to the Hawaiian Islands and a French section from Australia to New Caledonia will be in working order. The construction of the intervening portion between New Caledonia and Hawaii will presumably depend upon the rapidity with which the British scheme is now proceeded with. It is not probable that the increase of cable business between the northern and southern hemispheres on that side of the world will for some time to come justify the construction of two complete Pacific cables. From the commercial point of view it is therefore a question of which is to be first in the field. The predominance of British trade interests in those waters would appear to justify the desire of the British colonies to keep the cable connection under British control. It will be the business of the present cable conference to decide in what manner this result can most practically be achieved." Further on it is remarked that as time is of importance to the favourable conclusion of the undertaking, it is to be regretted that the representatives of the Australasian Colonies at the conference should find themselves under the necessity of very seriously delaying the proceedings by absenting themselves from England to attend the telegraphic conference at Budapest. This absence may last six weeks, and during the whole of the time the proceedings of the conference are in danger of being suspended. "At this period of the year a loss of six weeks may mean that no conclusion can be arrived at in time for proposals to be submitted during the present or approaching sessions of the Imperial and Colonial Parliaments. The delay may therefore entail the loss of a whole year, and Australia, to whom the communication to be established is of more importance than to any other of the joint partners in the undertaking, may hereafter be called upon to bear the blame of having at a critical moment impeded the initiation of an enterprise in which the Imperial Government and the Government of Canada had demonstrated their readiness to take part."

Institution of Mining Engineers.—The twenty-first general meeting of the members of the Federated Institution of Mining Engineers was held last week at the Institution of Civil Engineers, Great George-street, Westminster. At the opening meeting on 4th inst. the chair was occupied by the president, Mr. G. A. Mitchell, and there was a large attendance from all parts of the country. The President, in the course of his address, remarked that the history of mining told of a constant [gradual progress, and they must bear in mind the past and remember that as it had been, so it probably would be. Familiarity with electrical transmission of power would probably lead to many changes in the future, and, among others, to the more extensive use of coal-cutting machines. Coal cutting by machinery had not in this country been a great success in the past, notwithstanding periods of activity in the introduction of coal-cutters from time to time. By the use of coal-cutters many thin seams should become workable that had in the past been neglected. It was possible that in the future it might be to the opening up of thin seams, worked by coal-cutters, that they must look for the maintenance of outputs in some districts. With coal-cutters the output might be long maintained. The experience of the past should teach them to be very careful about prophesying the exhaustion of coalfields. Their trouble at the present moment was that both in Scotland and in England and Wales too much coal was being produced, and there was depression in the coal trade in consequence. It was unfortunate that trade was hampered so often by disputes between masters and men. Miners at the present day did not appear to realise in what an immensely better position they were than those who preceded them. Subsequently a paper was read by Mr. H. W. Ravenshaw, in which he dealt with certain precautions which he considered necessary in the use of electricity in coal mines, Although the use of electricity for lighting and the transmission of power in coal mines was becoming more general, and many of the plants had been running for some years, no serious accidents or explosions had within his experience been traced to its adoption. In some districts, where the seams were very fiery, colliery proprietors had refrained from using electricity. Some writers on the subject had inclined to the view that there was little or no risk of the ignition of gas by the spark caused by the rupture of a cable through which the current was flowing. That, however, remained to be proved, and it was much better to guard against a possible danger than to run the risk of losing even a single life. As a matter of fact, the risks were few and easily guarded against, and there was no reason why electric motors should not be used in the most fiery mines if proper precautions were taken in putting down a suitable plant and keeping it in an efficient state of repair. In the evening the annual dinner of the institution was held at the Holborn Restaurant. On Friday, early in the day, the members paid a visit to the works of the Electric Welding Company, Limited, Pimlico, and inspected the Thomson electric welding process. At noon the reading and discussion of papers was resumed at the Institution of Civil Engineers. Mr. Bryan Donkin contributed a communication upon "Powdered Coal for Firing Steam-Boilers by the Wegener and other Systems." Amongst the advantages of using powdered coal firing as compared with large coal, he stated to be the absence of smoke after the firebrick lining had become hot, continuous and automatic fuel supply, less dependence upon the stoker, more perfect combustion, more easy regulation of the exact quantity of air required and of steam generated, saving in cost of labour, economy of coal, no grate or grate-bars, no fire-doors, higher furnace temperatures, and increase of boiler efficiency from 15 to 25 per cent. Amongst the disadvantages were the cost of grinding the coal, which would vary according to the difference of locality and quantities ground, but might be taken from 9d. to 1s. a ton, and repairs to firebrick lining. Visits of inspection were afterwards paid to the Deptford station of the London Electric Supply Corporation and other works.

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MUNICIPAL ELECTRICAL ASSOCIATION.

The first meeting of the convention of this association has been held in London during the present week. We gave a full programme of the meeting in our last issue. The first meeting, on Wednesday morning, held in the United Service Institution, was well attended, among those present being Sir Courtnay Boyle, Major Cardew, and representatives of all the large electrical manufacturing firms. The papers were read in abstract, and we give below these abstracts, followed by the discussion and replies of the gentlemen reading the papers. The president (Mr. Arthur Wright, of Brighton) took the chair at half-past 10 a.m.

Presidential Address.

Mr. ARTHUR WRIGHT read his presidential address as follows:

You have done me the great honour of asking me to preside at this our first annual convention, and I feel I cannot take up a portion of your time to better purpose than by proving the pressing want of some such association as we are now inaugurating to further and protect the interests of the municipal electricity undertakings, which in the very near future will probably exceed 80 in number, and represent a capital outlay amounting to £4,000,000 sterling. I therefore propose to show how exceedingly numerous are the questions that are being constantly met with in our special branch of electrical engineering, and why, in my opinion, none of the existing societies can really supply our want. I think you will share my regret that the very nature of our problems, and the particular standpoint from which we municipal men have to look at them, prevents us from deriving the great benefit of having among our regular members the numerous experienced managers and engineers of companies supplying electricity.

Although the objects of this association are generally and very tersely stated in the constitution, I may be allowed to amplify the wording there by stating that, in promoting the special interests of municipal electricity undertakings by bringing together, for the purpose of comparing experiences, the men responsible for their management, we hope to succeed in getting the representatives of the ratepayers to participate in our discussions, and to obtain their valuable co-operation and municipal experience in trying to solve our difficulties, so that our recorded conclusions may receive the greater consideration from the head governing bodies. For the purpose of classification, I will divide some of the problems that have already confronted the management of municipal electrical undertakings into three distinct groups—those relating to policy, to commercial, and to technical questions. Although it could be truly said that some of the questions of policy come within the sphere of one, if not more, of the older societies, and that many of our commercial and technical problems could be advantageously discussed from a general point of view before some of them, yet it must surely be to the advantage of the community to have the particular interests of our industry safeguarded and properly represented by an association comprising among its members the representatives of the ratepayers and the technical officers in charge.

The group of "Questions of Policy" must obviously include those relating to what should be the proper period allowed for the repayment of loans. That some decision ought soon to be arrived at is evident when we remember that in London the vestries can get permission from the County Council to repay their capital in periods exceeding 40 years, whereas in many of the provincial towns 25 years is the period fixed by the Local Government Board. There is obviously no reason why posterity outside the Metropolis should be so much more generously dealt with, at the expense of the present generation, or why folks in the provinces, who have to pay all the expenses and suffer from the inevitable troubles incidental to the starting of a new industry, should also have to behave so much more handsomely to people who it must be remembered will have an advantage over us in being born 25 years later in the world's progress. Take, again, the question of assessment of electricty works and mains. The interpretation of the law on this point is so uncertain among experts that it is actually possible, in the case of two municipal electrical undertakings in the South of England, for the relative assessments to be nearly as 10 is to 1, although the capital invested is about equal. At first sight, to anyone not directly interested in the success of municipal electricity works this variation of assessment would probably not be considered very serious, as apparently it is only a question of taking money out of one municipal pocket and putting it into the other; but to the men responsible for the success of this one special department the question of assessment affects the vital results of the electricity undertaking paying or the reverse, and increases or diminishes the near possibility of a reduction in the tariff for supply, which they realise is necessary to ensure the general use of electricity among all classes of ratepayers.

The decision arrived at as to what policy should be pursued in relation to the profits obtained, has a similar effect on the rapid growth of municipal electricity undertakings. The practice of insisting on maintaining high tariffs so as to be able to hand over large profits to the general body of ratepayers, on the ground that they should be handsomely repaid for their risk in mortgaging their rates, is very naturally resented by those ratepayers who make use of their own municipal supply. They contend that by this policy they are being severely taxed, in the shape of having to pay heavy electricity bills, for the benefit of a number of people who we now know ran practically no risk at all, and as non-users do not help their own municipal enterprise. Again, when we remember how prone some municipalities are to pride themselves on the large profits made in their undertakings, and when we remember the policies advocated by some of our friends who would lead us to imagine that the object is simply to supply electricity to those who can afford to pay the necessarily high initial price, it is evident that good must come from our discussing this point, and bringing home to the governing bodies the truth that the criterion of success of a municipal electricity undertaking, trading in what cannot be called a necessity, is not so much the profits made out of the undertaking as the more or less general use the ratepayers make of the supply offered.

Those who advocate putting aside a large proportion of the annual profits to building up a reserve fund for use in case of unlooked-for contingencies are often charged with want of consideration for the general ratepayers who backed the necessary cheque in starting the undertaking; these critics, however, forget that in this matter it is the duty of a corporation not only to start but to continue to supply a cheap and satisfactory service, and to insure against any possible mishaps that may arise in the future. Again, the question of creating a mutual electricity works insurance fund seems a fitting subject for discussion, considering how all our works are now being tarred with the same brush by the fire offices, and classed by them among the same hazardous risks as factories, etc. Again, the practice of the various municipalities differs considerably in deciding whether one or separate committees should manage the gas and the electricity departments. The former practice frequently prevails, and what seems to many of us the inevitably slow progress that results from such a policy is not at present fully realised. In some towns human nature seems to be so over-rated that their corporations have made one manager responsible for these two competitive departments.

Another point in connection with the general policy that is to be followed in carrying out municipal electricity undertakings is one on which electricity works managers are not by any means all agreed among themselves—namely, whether a corporation should make all ratepayers pay a uniform profit on the cost of production of the electricity they individually consume, or charge a uniform price to everybody. I scarcely need add that the two systems cannot both be adopted. The former has the advantage of justice on its side, while the latter has that of greater simplicity; unfortunately, however, it involves the commercially unsound principle of charging the same price for commodities which may individually require capital outlays differing as much as tenfold or more. Again, owing doubtless to the youth of our industry, no definite rule has

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yet been established among municipalities as to how they should charge for electricity consumed in their street-lighting and public buildings; whether, for instance, this should be done on the sound principle of having only one universal tariff, or should special tariffs be arranged for their own municipal consumption. The latter course, in view of the charges that are constantly being made of some corporations making their electricity profits out of their own pockets, seems difficult to justify.

The wisdom, or the contrary, of municipalities taking joint action in threatened patent litigation, or in view of new parliamentary regulations or restrictions, wants discussion and settlement. The questions whether municipalities should carry out the wiring of private premises in competition with local tradesmen; whether they should have powers to hire out motors, arc lamps, and fittings; the advisability of establishing municipal telephone systems, electric fire-alarms, and electric fire-engines; the possible benefits of combining the water and electricity works; the use of the plant in periods of light load for the production of such by-products as disinfecting fluids, acetylene, and carborundum, etc., are all interesting problems of policy which, I trust, will be ventilated and argued at our conventions.

Another municipal variation of practice is shown by some believing that it is to the interest of the ratepayers to employ a sufficiently strong resident engineer to carry out both the design and the running of their undertaking, on the ground that no one but a resident can properly grasp and retain the local bearings of the problems involved in a distribution scheme of the nature of electricity supply, while others consider that a consulting engineer, owing to his having the opportunity of gaining much more varied experiences from all sorts and conditions of towns, would serve them in better stead. On the answer to the above delicate question of course depends what should be considered the proper remuneration of the resident engineers who have the virtual control, whether their councils fully realise it or not, of property amounting in many cases to hundreds of thousands of pounds. The touring experiences of many of our best electrical engineers is advantageous to the men themselves in gaining fresh experiences, but it increases the unfortunate loss to the corporations when the engineers are snapped up for better appointments elsewhere. The existence of this constant system of changing proves beyond all doubt that many corporations have not yet realised the value of the immense experience these men take away with them, and how impossible it is to replace their experience by even better men until some considerable time has elapsed. Some corporations fully see the advisability of getting their engineers to visit other electricity works for the purpose of keeping up to date. The great extent to which the ratepayers benefit by this policy is not, I am sorry to say, apparent to all the governing bodies.

Although many of our senior brother municipal officers will be prone to think that some of the above questions do not come at all within our province for discussion, I feel that if we obtain the valuable assistance of the chairmen of our committees in discussing and solving them there will be little difficulty in getting the correct principles accepted and adopted by our councillors. All the above, and a host besides, are questions of policy that press for solution, and I think many will agree with me in thinking that if we leave them to the other societies to fight out, we may as well adopt the equally slow course of leaving each corporation to worry for themselves when they are individually confronted with them. The founders of this association saw that co-operation in arriving at conclusions upon these problems would save a great deal of time. and would avoid the repetition of a vast amount of work by the different councils. They also saw the importance of putting in black and white the results of careful consideration by competent men of the different policies advocated, so as to afford help to those among their *confrères* who may be in need of it.

With the second class of problems connected with our work—viz., those requiring consideration from a commercial point of view—it seems to many of us quite impossible to get this class of question satisfactorily and adequately discussed before societies, however influential and well organised, which comprise among their members men representing absolutely conflicting interests, and it appears equally futile to discuss these questions before institutions including among the members the managers of electricity supply companies, whose object in developing their business—viz., to get the biggest return on the capital expended—is so entirely different to ours in trying to supply the greatest number of ratepayers at the smallest possible cost. Moreover, it can hardly be fair or interesting to the majority of the members of existing engineering institutions for us to take up their time discussing problems which can only properly be thrashed out before a special body representative of our particular subject of municipal electricity supply.

Under the heading of "Commercial Problems" must come the important question of the proper organisation of the electrical staff—that is to say, how to so organise a staff and separate the undertaking into separate departments as to be able to define the duties and responsibilities of each member of it, and to ensure against any discontinuity in the business in case of illness or resignation of the chief officers. Whether the principle of giving the staff a bonus depending on the results of the year's working is likely to be to the benefit of the ratepayers or not is a question on which much can be said on either side; and it ought not now to be difficult to decide what should be considered the proper scale of remuneration to the different members of the staff in accordance with their term of service, so as to avoid as much as possible the inconvenience and loss of experience to a corporation of having their officers merely use the undertaking as a sort of training school. I think a very useful purpose will be fulfilled by our association if we could all agree on some proper method of keeping electricity accounts, or, perhaps, I ought to say of properly filling in the Board of Trade regulation form of accounts.

Everyone will now admit the great value electric lighting statistics, financial as well as technical, would be providing they were made on an absolutely uniform basis, and I trust some of our members will early suggest some form which we can all approve and adhere to. The question as to the right method of determining the cost of electricity supply has yet to be thrashed out, as it seems to some of us that the usual method of taking the average cost of all the units delivered is as useless for the purpose of calculating the cost of supplying any one class of consumer as if a land agent were to calculate the cost of a particular plot of ground in a town by dividing the total land value of the town by its total area. On this matter of costs depends the very important question of the actual cost of electrically lighting streets; also whether there is any justification, commercial or otherwise, for the plan adopted in many towns of charging a lower rate for electricity consumed in motors than in lamps.

Another most interesting and still unsettled point is what should be the basis on which to calculate the cost of energy wasted in feeders, transformers, etc., for the purpose of determining the relative cost of different systems of distribution. I have not yet succeeded in meeting two men agreed as to how this should be done. Again, it has not yet been generally recognised, as some think it ought to be, that it pays a corporation to cater in our industry for the same class of people that proves so remunerative to the railway companies—viz., those who choose to travel third class—and that it would probably be very much more advisable for corporations to run mains in their districts than only into the districts occupied by the houses of the rich and often-absent residents or the early-closing shopkeepers. To put it shortly, many of us have still to realise and prove to our governing bodies that it may be far better to get electricity used in a poor man's kitchen and one dwelling-room than it does to get it into many of the drawing-rooms of the wealthy. Again, you will all agree, I feel sure, that it is very important, in order to inspire confidence among the ratepayers, to show as early as possible after the starting of a municipal electricity undertaking that it can be made self-supporting, and therefore independent of the rates. With this object in view it is an interesting problem in electricity supply to find whether capital is better employed in the early days of an under-

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taking in extending its sphere of operations into all parts of a borough, or in spending money on coal-saving refinements. To point out a danger confronting many of us, I may add that sound business men often express a belief that electricity undertakings would progress much faster if their managers took as much interest in understanding the commercial problems as they do in the over-absorbing engineering details and the fascinating scientific points connected with the industry.

The subject of wiring regulations and fire risks is one that has already received a great deal of attention, and I submit that it is still an unsettled question whether we are not weakening our position by enacting pages and pages of regulations which we have no very practical means of enforcing, and cannot afford to keep a sufficient number of inspectors to see carried out. Although I believe a certain amount of regulation writing is necessary in the early days of any industry, yet, in view of the utter absence of observed regulations concerning the use of paraffin lamps and compo gas-pipes, one may be forgiven for thinking that it is better to realise at once the futility of electricity supply authorities formulating regulations; that the proper people to do this and see them carried out are the fire offices; and that the more thoroughly this is recognised, the more likely these offices will be to fall into line and organise their staffs so as to ensure strict and general inspections. This seems to me to be the only way to improve the character of the interior wiring work, which at present varies much in quality.

With regard to the last group of questions, those of technical interest, which to most of us are infinitely more attractive than those of commercial expediency, it is hardly necessary for me to do more than enumerate many of the most pressing problems. Foremost among these, in my opinion, must surely stand the question of what should be considered the best system of distribution of electricity to any particular town or district. That the present state of things cannot be finality is obvious when we bear in mind how numerous are the different methods at present advocated and in use for towns of comparatively the same class. Owing to the absence of some such association as ours, this vital question has not yet been thrashed out by men who are unconnected financially with particular systems, but I hope we shall not be so very much longer now in settling upon some method of selecting the plant and means of distribution which should be put down by a municipality, so as to ensure an absolute continuity of cheap electricity supply, and at the same time bear the severe practical test of enabling the manager and the rest of the officers who have to work during the day to go home comfortably to their 5 o'clock tea without expecting every moment to be rung up on account of some mishap or other. In connection with this battle of the systems must be decided the proper voltage of supply to be adopted by works to be erected in the future, also whether it is advisable, and, if so, in what state of their progress, for works in actual operation to raise their voltage of supply, and the best method of effecting the change. I only wish I could see a chance of our discussing within the next year or so such specially interesting technical problems as the advisability of earthing the neutral conductor of a low-tension system of supply, the most suitable class of mains to adopt, the proper size of feeders and generating units, the advisability of adopting for commercial, if not technical, reasons one uniform periodicity for alternating-current plant, the wisdom of interconnecting all the low-tension network of a town, etc.

Although the question of the best design for an electricity works depends so much on local circumstances, yet the main considerations affecting this ought now to be determined. The question of locating faults on a system of distribution is another point on which we must all derive benefit by comparing our different methods and difficulties. Up to the present busy men in practice have been apt to keep their various methods too much to themselves, forgetting that probably the combination of other methods with their own would be of great value. As it has now been recognised that the present system of wood casing for interior wiring cannot be considered finality either from an electrical or æsthetic point of view, a paper on this subject up to date would be most interesting and useful to all of us. Again, the best means for lighting streets, wide and narrow, can now, with the experience of many of our members, be advantageously discussed.

Our constitution has been framed on a very liberal basis, and I trust we shall escape the internal troubles which some of the older societies have had. On Friday we proceed to elect from among our members a president, two vice-presidents, three members of committee, a treasurer, and a secretary.

In conclusion, I feel sure that if we can only persuade ourselves to be mutually communicative and ready to exchange our views and experiences, the result will be so beneficial to the community at large that they will be as thankful to the members who first took up the idea of forming this association as we ourselves ought to be to Mr. Madgen, our first very energetic hon. secretary, who by his ability in organisation has done so much towards making this association promise to be a permanent and useful success.

Mr. A. S. BARNARD, M.I.E.E., A.M.I.C.E., borough electrical engineer, Hull, read a brief abstract of a paper he had prepared on

Electricity Supply at 220 Volts.

The author dealt chiefly with the advantages and disadvantages of the use of 220 volts on the distributing mains, and thought it was probable that many engineers whose stations were at present working at 100 to 110 volts would gradually persuade their customers to take a supply of 200 to 220 volts, which would at any rate be an immense gain to the supply works. He considered that in the majority of cases the change likely to be made would be the doubling of the pressure throughout. The advantages of the changes were, briefly, as follows: (1) existing mains can supply twice as many customers, at the same time reducing the percentage of loss in the cables by one-half; (2) variations and fluctuations due to the switching on or off of motors or large groups of lamps, or carelessness in switching dynamos in or out at the station, are all reduced by at least one-half; (3) new customers can be supplied at a much greater distance from the station. After considering the effect the change would have on present systems, the author proceeded to explain how it would affect the wiring and fittings on consumers' premises. As far as present experience went, there was little, if any, increased danger of fire by adopting 220 volts. In regard to the neces sity of a higher-efficiency lamp, he adduced evidence to show that 220-volt lamps could be obtained which compared very favourably with the 110-volt lamp.

Alternating-Current Stations and High-Voltage Lamps.

This was the title of the paper written by Mr. H. W. COUZENS, borough electrical engineer, Taunton, and in alluding to the principal points contained in it, he said it was originally intended for a magazine note on the subject it dwelt with, and that accounted for some of the prefatory remarks, which might otherwise seem to be unnecessary. His object through the paper was to bring before the notice of the association some of the cases in which high-voltage lamps would prove of service to the alternating engineer. In the first place, it would lead to the extension of the sub-station system of distribution to scattered residential districts to take the place of distributed transformers; and, secondly, the substitution of increased pressure in these places would be a comparatively simple matter. Alternating-current engineers had been slower to take up this question as it had not been forced so necessitously upon them. He had every reason to believe that the advantages of increased pressure and reliability of lamps would make themselves felt in the near future.

DISCUSSION.

Mr. R. C. Jackson, the engineer of the Newcastle-on-Tyne Electric Supply Company, said that he thought too much attention had been paid to the saving in mains when 200-volt lamps were used. The more important point, in the consumers' interest especially, was that of the efficiency of the lamps. He thought no

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one would dispute the fact that 100-volt lamps were more efficient than 200-volt lamps, even as 50 volt lamps were better in this respect than 100-volt ones. He thought the time was coming when the fight between the gas interests and electric light would be even more keen than at present, and the use of small candle-power lamps would be of great service in this struggle. High-voltage lamps were not so economical as those now in use, and he doubted if lamps of 4 c.p. and 5 c.p. could be made to work at 250 volts. This point he considered more important than the saving in mains. He finally would suggest that the association would do well to take up the question of the relative values of different types of lamps for different voltages and decide definitely on their respective efficiencies and life.

Mr. V. A. H. McCowen, of Belfast, considered that the great feature in the 200-volt system of distribution was that of the increased capacity of the mains. If the Westinghouse Company's application for the extension of time for Dr. John Hopkinson's three-wire patent was granted the higher-voltage lamps would be of great value, as with them heavy royalties could be saved. He considered that Mr. Barnard in fixing the limiting area of supply with the 110-volt three-wire system at the square mile had fixed it too low. This limit could be raised considerably.

Mr. J. H. Rider, of Bolton, said it was amusing to see how the "low-pressure men" had been compelled to rush on the high-pressure work with 220-volt lamps on their mains. The supporters of the low-tension system had always said that the high-tension system was an essential one for incandescent lamps, and that arc lamps supplied by it were bad. Now the low-tension gentlemen were prepared to give up single arc lamp or two in series and small motors, and to adopt a system by which four arc lamps were the least possible number in one place unless one consumer cared to have, say, two lamps in series with two lamps in the next consumer's premises, with the objection that his light could be turned out by his neighbour. To the alternating system this 200-volt lamp was in these days of low-tension mains equally useful as the low-tension system, and at the same time by means of a transformer one, two, or any number of arc lamps could be supplied. He considered that the alternating system had none of the disadvantages of the inflexible supply of direct currents at high voltages.

Mr. C. H. Wordingham, of Manchester, said that the works in that city had given the lead in this matter of high-voltage supply, as they had a five-wire system with 400 voltage across the outer wires in working order before anyone else had attempted it. Their success showed the Board of Trade that the higher voltage was safe, and helped, he thought, in obtaining the permission to use 200-volt three-wire systems elsewhere. He had not had much experience of 200-volt wiring, as most of the consumers were supplied at 100 volts, but he would warn those present not to accept the statement that ordinary fittings could be used. He had experimented with some of these, and then showed the charred remains of some porcelain fuses which had failed to break a 200-volt circuit. The fuses had been supplied with three ampere fuse wire, and then a current equivalent to 50 amperes turned on. These fuses would break the circuit, however, if the porcelain covers were not on. He thought the 200-volt lamp had not yet killed the five-wire system, and that the difficulty of using single arc lamps, etc., referred to by Mr. Rider could be got over as follows: in those districts where small shopkeepers were likely to want arc lamps, two additional mains could be run, and two balancing transformers used. This would practically make a five-wire system. As regards Mr. Rider's remarks on the alternate-current supply at different voltages, he did not see why electric lighting undertakers should be obliged to give an infinite number of pressures to the various consumers. This would lead to a large number of different transformers being required, which he thought inadvisable. He did not agree with Mr. Barnard's statement that the 220-volt supply would reduce the cost of starting resistances for motors, as although the current was halved the voltage to be observed by the resistance was doubled.

Mr. C. H. Stearn, of the Zürich Incandescent Lamp Company, considered that it was a fortunate augury that the Municipal Electric Association had placed this high-voltage lamp question in the foreground of their first meeting. He believed that the opposition to the use of these lamps would die away. As regarded the fittings to be used ordinary care must be taken in their selection and although a few short-circuits might occur, he did not think they would be more numerous than with 100-volt pressure. He did not agree with a previous speaker that the efficiency of an incandescent lamp increased as the voltage decreased. A diminution of the section of the filament did not affect the efficiency unless the mechanical strength of the filament was prejudiced. A perfect filament of only two mils diameter could be made equally efficient with any filament to work at 50 volts, and mechanical support could be given to those thin filaments if required. He did not think that high-efficiency lamps were in general use, and considered that the average lamp as now sold required from 3·7 to 4 watts per candle, whereas 230-volt lamps, requiring only 3·5 watts per candle, could be easily obtained. He would recommend that the engineers should be content with a somewhat lower efficiency at first, as those efficiencies had satisfied them at lower voltage.

Mr. H. Gibbings, of Bradford, did not consider the time was ripe for a final decision in these matters. They had used the high-voltage lamps successfully at Bradford, and had found that 3·7 to 3·8 watts per candle was the maximum consumption required. We should be able to decide the matter better in a year's time. At Bradford they had supplied some 380 customers at 230 volts during the past six months without complaint. He did not think that the low candle-power lamps were in demand, as the following figures of lamps now connected to his mains would show: 180 8 c.p., 10,491 16 c.p., 131 25 c.p., 1,084 32 c.p., 166 50 c.p., 120 100 c.p., 3 150 c.p., 5 250 c.p., 12 300 c.p.

Mr. J. E. Stewart, of Derby, thought that trouble might be found in changing an installation over to the other.

Mr. W. Arnot, of Glasgow, said that he had no doubt but that the different objections now found to supplying at the higher voltage would be overcome, and that the 200-volt lamp would be as safe and as efficient as the 100-volt. He referred to a conversation with Mr. Swan some years ago, when the speaker was assured that a 70-watt 16-c.p. lamp would be practical. Everyone knew how much this efficiency had been exceeded, and Mr. Arnot did not doubt but that the high-voltage lamps would be similarly improved. He also thought that the manufacturers would have no difficulty in providing switches, fuses, etc., to withstand the higher pressure. He personally believed in grouping such apparatus as much as possible. He said that the questions raised between high and low tension had been much exaggerated, as both systems had their advantages in different places. The real question in issue was rather whether direct or alternate current systems should be used.

Sir Courtenay Boyle said he was extremely grateful to them for having given him an opportunity of listening to what he considered a most practical and useful discussion. He was astonished at the exceedingly valuable character which had distinguished the remarks which had fallen from the various speakers. He was quite certain that such discussions as were carried on by their association must be useful, not only to the municipalities and not only to the Government and the particular department which he served, but also would be of advantage to that individual whom he had heard referred to in terms of unusual respect—he meant the consumer. Because, after all, they were all of them working in the interests of the consumer—he did not mean to say that the interests of the producer were to be disregarded; on the contrary, they were to be carefully safeguarded, but they were all of them working in the interests of the consumer, and it was to the consumer that they must look for the approval of their action. He had heard the presidential address and the discussion on the papers which had been read, and he only wished his engagements would permit him to stay longer. He was convinced that they who were dealing with the science which was still a young science had much to learn by discussion with each other. He was quite certain—he had heard speakers use language to fortify his opinion on this point—that hereafter we should know more than we do now upon the various points which had come up that day. He was somewhat appalled by the speech of the worthy alderman from Bedford when he said that the regulations of the Board of Trade were still in many respects very defective, and that there were several points which had not been dealt with. He could only say that if they would advise the Board of Trade to deal with them, they would act on that advice. The president, in his address, alluded to one or two subjects which might occupy the attention of the members of the association, and they were essential subjects, and which must be discussed by a body like theirs, but there was one suggestion which he might make, and that was: could anybody find out a name for a Board of Trade unit, which was now expressed in an extremely incongruous and lengthy term. It might be of interest to know that a short time ago he nearly succeeded in getting it called a Kelvin. If it had been, he was sure it would have met with general approval, but Lord Kelvin said he was connected with a supply meter which he was about to bring out, and that therefore it would not be proper to connect his name with a Board of Trade unit. There was another point which was still more important. He thought they at the Board of Trade must look to the municipal electrical engineers who were interested in the localities to guide them as to the behaviour of supply meters. As they knew, the duty devolved upon the Board of Trade to approve the pattern of a supply meter. Up to the present they had had considerable difficulty in discharging this duty, but he hoped some of the difficulties had now been overcome, and that they would be able to do something in that direction, but they must look to the local bodies to tell them how these meters worked in practice. Major Cardew could do it in a laboratory, but that was a work in which he thought a body such as that might offer very useful and very valuable assistance. But all the duties beyond it were sure to be well done, if he might judge from what he had heard that day. He offered them his hearty congratulations, and urged them to continue the work they had so well undertaken. If any assistance could be given to their discussions by the department which he served, it should be heartily at their disposal.

Reply to the Discussion.

Mr. Barnard, in replying to the discussion, dealt first with Mr. Rider's remarks, and said the points which he had depended on were small candle-power lamps, the use of single arc lamps, and the inflexibility of the 220-volt system generally. He thought the system could not be quite inflexible when it was so easily altered in central streets or central districts by the five-wire system by means of the motor transformers. This had been done in Bradford, and it was what he proposed doing in Hull in one particular district. It got over the objection of their being unable to supply 100 or 50 volts for a single lamp of the power of arc lamps. With regard to small candle-power lamps, Mr. Gibbings said they had a proportion of only 180. He believed that in Hull theirs was a smaller proportion than that. He did not think they should have 2½ watts for an 8-c.p lamp, and he did not think the consumers desired it. With regard to fire risks, Mr. Wordingham certainly managed to get a fine show of broken fuses, but he had succeeded

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in making as big a result with finer fuses. (**Mr. Wordingham**: I congratulate you.) He thought they would find that they could rely on the makers to give them fuses, with very little alterations, that would answer for 200 volts.

Mr. Cousens said one predominant question seemed to be that of lamp efficiency raised by Mr. Jackson. He believed Mr. Jackson was engineer to a supply company, and probably the company supplied lamps to the consumers, but that, he believed, was not the general practice among corporations. They left the consumers to get their own lamps, and the consequence was that the consumer preferred a lamp that would last a long time to a lamp with a short life and a merry one. The consumer found a 3½-watt lamp the best, and that was precisely what he would get if he had a 200-volt instead of a 100-volt.

Municipal Control of Wiring.

The next paper to be discussed was that of Mr. C. H. Wordingham, city electrical engineer, Manchester, on "The Control by Municipal Authorities of Consuming Devices, and the Wiring connecting them to the Mains." Mr. Wordingham gave a short abstract, in which he pointed out that much doubt existed as to what power municipal authorities had for making regulations for the control of wiring, and although it was greatly to be desired that the Board of Trade should assist municipalities he showed that there did not appear to be much prospect of this being done. The authority given by provisional orders was found not be sufficiently definite for the purpose, and other orders must be obtained. Having mentioned the course adopted by the Glasgow Corporation, he said, although that was good, something more was wanted, and advocated the appointment of the municipal electrical engineer as a kind of consulting engineer. He also advocated a fee being charged. This fee would be small in the case of a very small consumer, and, of course, larger for a larger consumer. Among advantages which would accrue from such a course he enumerated that of the security to a consumer in being able to obtain impartial and good advice, and of having his work done under proper supervision, instead of the consumer being left to the interested advice of contractors. He felt this was a better alternative to the corporation carrying out the wiring themselves, which course would be far more likely to cause friction. The author proceeded to suggest the various headings under which these rules might usefully be framed, and the paper concluded with two suggested resolutions to be proposed for adoption at the convention for the carrying out of this object. The resolutions were as follows:

Resolved—That this convention of the Municipal Electrical Association is of opinion that the need of a standard set of regulations for controlling the fixing and connecting of consuming devices supplied from municipal electric supply stations is urgent, and that such regulations should be drawn up and adopted by members of this association.

Resolved—That a sub-committee of members of this association be formed to draw up a draft set of regulations, and to enquire what powers exist for enforcing such regulations when made, and also to ascertain how further powers for this purpose may be obtained if necessary; the sub-committee to have power to confer with any person or body of persons having special knowledge of or interest in the matter, and, subject to the approval of the council of this association, to obtain legal advice on the matter. The sub-committee to present a full report of the work to the next convention.

Discussion.

Mr. Lister Taylor, on behalf of a fire insurance company, said that at Liverpool he had found the installation work done by the local supply company most satisfactory. In fact, where he knew the company had done the work his duties in inspecting would be considerably lightened. He believed that Mr. Wordingham's proposals would work well, but he and Mr. Wordingham could not agree on the meaning of the proposals in the paper. In small installations, the speaker said that the cost of inspection was more than the premium obtained, and he seemed to think that it was safer to take the risk without inspection in these cases.

Mr. R. Hammond congratulated the association on the good attendance and success of their first gathering. The subject before them was a most important one. He had had experience of bad contractors, and had found it necessary to refuse two or three installations in each town to prevent the use of bad work. He did not consider Mr. Wordingham's proposal likely to injure the consulting engineer, as anything tending to raise the standard of work meant, in the long run, work for the expert engineer.

Mr. Chamen was to speak on behalf of the contractors, but said he could not claim to represent the wiring contractors, and certainly hoped he would not be taken to represent the bad contractors referred to. He believed in a code of good rules being enforced, but did not think the corporations should take up wiring work themselves.

Mr. J. S Raworth said that that was the only subject before the meeting in which he could claim to have no personal interest. He thought the tendency was to err on the careful side, as it took great premeditation to cause danger with an electric light installation. He considered that the worst installation of electric light was far and away better as regards safety than the very best gas installation. In fact, a previous speaker had stated the fire offices' views of the case to be that with small installations it was best to take the fees and not to bother with an inspection, as there was no need. He did not believe that any rules empowering a central-station official to enter an Englishman's house could be enforced. The consumer would prefer to go back to the gas and be blown up.

Mr. E. Manville believed in getting the general opinion of all the engineers, and then adopting one good all-round set of rules, rather than having several individuals each drawing up his own. He believed that it was hardly advisable for the corporations to do wiring work, but the penny-in-the-slot system with gas had necessitated a similar course with the gas undertakings.

Mr. W. Arnot, of Glasgow, said that all industries had suffered in the same way, and he had seen some gasfitting work in Glasgow disgracefully done. He was adverse to making the corporation responsible, as the public then would expect to be compensated for all defects in installations passed by the corporation officials. He quoted an amusing case where a man in Glasgow walked over a barricade as high as his chest and claimed £5 damages. He thought the officials had at present sufficient responsibility without taking up this new department, and also pointed out that the Continental practice was worse than that in England.

Mr H. Talbot, of Nottingham, believed in having rules and enforcing them. He had found by refusing to pass one or two installations that he could keep up the character of the work.

Mr. Panton, representing the Electric Light Committee of Bolton, thought if the corporation did the work themselves it would give the consumer a guarantee. He enquired if there was more than one town in which installation work was done by the corporation.

Alderman Carey, of Cardiff, supported these views, and **Alderman Higginbottom**, of Manchester, opposed them, and said he preferred the "authorised workman" system in use in Manchester.

Mr. Faraday Proctor, of Bristol, said that the corporation had not legal power to enforce the regulations. He had made a rule that if the installation did not come up to the required standard a charge of half a guinea should be made for the second test. He had imposed this charge some 50 times in the last few years and found the contractor preferred to pay rather than lose his credit.

Mr. J. E. Stewart, of Derby, had found that the fire offices often wrote asking particulars of installations he had passed, and he thought in future of charging 10s. 6d. for information so given.

Alderman Talbot, of Huddersfield, raised a most important point. If the corporation had the monopoly of the wiring, the increase of consumers due to the personal influence of rival contractors would cease. He considered that much of the success of central stations was due to the energy of the wiring contractor.

Mr. Albion T. Snell thought that the inspection of the work in progress by a consulting engineer was more likely to give satisfactory results than one inspection when the work was completed. He thought the consulting engineer would lose largely by the change proposed by Mr. Wordingham.

Mr. T. P. Wilmshurst, of Halifax, thought that they had power to make regulations, as Section 6 of the Act empowered them to make by-laws. The town clerk and himself were busy drawing up such laws, as their authority had been set at defiance by a contractor in Halifax who was also a tobacconist.

Major Cardew said, before speaking to the paper, he must be allowed to congratulate them on the extremely satisfactory attendance and the prosperous appearance of this convention. It was very satisfactory to the Board of Trade to see that that association had shown their confidence as usual in the Board of Trade by coming next door! As regards the paper, he would have thought from his experience that they would almost have had enough of regulations; it was quite a new feature to find them so satisfied with the regulations that had been made that they proposed to add a few of their own. That spoke well for the way in which the regulations were working out. There seemed to be a doubt first of all whether, assuming that it was desirable to make regulations, they would have any power to enforce them. He did not speak as a lawyer, nor did he attempt to interpret Acts of Parliament, but it seemed that somebody had discovered that there was a power of making by-laws. That was in the first Electric Lighting Act, but the power to make those by-laws was subject to the approval of the Board of Trade. These by-laws were to be for regulations for the protection of the public safety, but then how far that would enable municipalities to make wiring regulations was very doubtful. Wiring regulations were bound to be more or less dictatorial. They were to do this, or they were not to do that, and not merely to enunciate principles. So long as they could enunciate and enforce principles he thought that would be satisfactory to all parties, but the tendency was rather for the corporation electrical engineer—of course he would not have fads, but to have his own ideas as to how a house ought to be wired, and these ideas might be more or less expressed in the by-laws. Then, of course, first of all, it would be for the Board of Trade to consider whether such regulations should be approved or not. It

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would be most injudicious to say now how they would consider anything of that sort until a case had been submitted to them, but obviously it would be undesirable to tie up the freedom of the consumer any more than it was absolutely necessary to secure the result which they wanted—that was to say, safety for himself and avoidance of interference with the safety of others. At the meeting of the Board of Trade when they last discussed the issue of regulations they were rather pressed to make the regulations dealing with house installations more stringent than they had been, and they did move in that direction as far as they could while still preserving to the consumer a sufficient amount of freedom, as was obviously indicated in the eighteenth section of the Electric Lighting Act of 1882, in which there was a clause on wiring which debarred the undertakers from enforcing any particular kind of lamp, etc., on the consumer. That clause clearly indicated a certain fear on the part of Parliament when this Act was settled lest the undertaker should assume too much power over the consumers, and thus perhaps to some extent to deprive the consumer of the benefit of the new systems, and perhaps to leave him at the mercy of one particular view as to how electricity might be supplied, which might not be satisfactory. To sum up this question of by-laws, he should say it was desirable in many cases that by-laws should be made. The Act gave the power and enunciated the purposes for which these by-laws should be made, and therefore in any case, whether the corporation found it necessary or desirable, on the ground of public safety, to add to the regulations of the Board of Trade generally, he thought it was advisable that they should make those by-laws, but that they should be of as general a nature and as far as possible enunciate the true principles and avoid particularising as to the particular kind of wires. As regards inspection, he should say certainly that they were not only entitled, but that the Act suggested that they should inspect before any connection was made. It seemed to him that it was intended that they should by the expression in the Act, "reasonable satisfaction," make some sort of inspection, and that any consumer who refused such permission would have only himself to thank if they refused to supply him. The general feeling was that an "Englishman's house is his castle." It was difficult in some cases, and it was not quite satisfactory to inspect after all the work was covered in; therefore, where they had early enough intimation—where the application had been made before the wiring was carried out, it seemed to him very reasonable that the engineer should call round and see the work while it was in progress, and just have his eye on it. No consumer with any sense would object to such an inspection. He concluded by again expressing his pleasure at being able to attend that day.

REPLY TO THE DISCUSSION.

Mr. Wordingham, in replying on the discussion, said a great many points had arisen on his paper, and it was very difficult to adequately reply to all the speakers. He was sure he was expressing the feeling of the meeting and of the whole association in saying how gratified they felt at having Sir Courtenay Boyle and Major Cardew with them that day, and it was most gratifying to have heard their speeches. As regards Major Cardew's remarks, they quite appreciated the difficulty of a corporation interfering too much in any consumer's premises, and also insisting on very minute details as to the system of wiring to be adopted, and that was why he brought forward his suggestion that the borough electrical engineer should be allowed to advise on these points. He would then be more in a position of a consulting engineer, but the work would be more personal than municipal. There would not be the irritating feeling of the corporation interfering. His idea was not to shut out the consulting engineers, but to have one man for every installation however small. A small fee should be paid for a small installation and a larger fee for a larger installation As to Mr. Snell's remarks about the consulting engineer personally inspecting all the work, he could not believe that a good consulting engineer could possibly personally look after every detail. He must have assistance, and so would the corporation engineer require competent assistance to go thoroughly into every question. His experience was that consulting engineers did not hanker after those wiring instal lations. It was most satisfactory to have Major Cardew's opinion as to their right to draw up certain by-laws and to inspect. He thought it was quite clear they were required to inspect, and the association might draw up a model set of by-laws, which should be on the lines Major Cardew had suggested. The Act was right in precluding the corporation from forcing any particular lamp on the consumer. Once the corporation had found a fault in a house, there their responsibility ended. With regard to the installation test, he thought that was absolutely misleading, more particularly in the case of a new building. As to the liability of corporations interfering too much with the wiring, that was his reason for proposing that they should be a distinct body through their engineers. As regards landlords and fittings, he found in Manchester that the landlord always did the wiring, and no doubt he charged it to the tenant. The uncon trolled contractor was very apt to put in twice as much light as was wanted in order to make plenty of work but that was very much to be deprecated. He did not oppose 200-volt lamps; he advocated them, but he felt that great care must be exercised in putting in the fittings for that pressure.

An adjournment was here made for lunch: after which a visit was made to inspect the Deptford station of the London Electric Supply Corporation, Limited.

THURSDAY.

The proceedings were resumed at quarter past ten, the chair being again taken by the president, Mr. Arthur Wright.

Letters of Regret.

The SECRETARY read letters from Lord Kelvin, Prof. Kennedy, and Mr. Kapp expressing their regret at not being able to be present at the convention, and congratulating the association on inauguration; and also letters from Mr. A. W. Heaviside (Newcastle) and Mr. George Wilkinson.

Cost of Electricity Supply.

The PRESIDENT then read a brief extract of his paper on "Cost of Electricity Supply." He pointed out that at present no very definite basis had been decided upon by which to calculate the cost of electricity supply, and illustrated the uncertainty on this question by the fact of so many different tariffs being still in existence. He discussed the usual methods of averages and that of Dr. Hopkinson, and as no one had hitherto published the results of applying the latter to actual figures, he proceeded to do so with those of the Brighton undertaking for the year 1895, using two methods, which he submitted were based on Dr. Hopkinson's method. In analysing the accounts he pointed out what he considered should be taken as constituting the cost of supplying electricity, and how the different items could be divided into the two classes of running and standing-by costs. He showed how a curve of total monthly expenditures could be analysed and fairly represented by an empirical formula. He then called attention to an obvious corollary of the ascertained low cost of continuing to supply electricity compared with the heavy charges for getting ready to do so, and that there was a greater necessity for differential tariffs in towns where coal was cheap than where it was dear. He then discussed how each consumer's proper proportion of the standing charges should be apportioned, and gave the method adopted by the Brighton Corporation in ascertaining this. Having agreed on a basis on which to estimate the cost of supply to any one consumer, he then pointed out that it was possible to make a profit and loss account for each year showing those consumers who proved profitable and the reverse. He then recorded some important conclusions which followed from this analysis of electricity costs, among the most important being that he considered that it was the duty of a municipality to charge on a system of uniform rate of profit than a uniform price. He stated that the extremely low price at which electricity could be supplied on the former basis more than compensated for its comparative complication. He urged the advisability of maintaining the initial price at the highest possible figure until the standing charges were covered, and then the reduction to as low a figure as was compatible with a small safe annual profit. He also stated, in his opinion, that it was erroneous to suppose that the cost of supplying short-time consumers, such as offices, etc., would very much diminish as the business increased, as the cost of this class depended almost entirely on the standing charges, and not on the running costs. As an illustration of the effect of these standing charges, he pointed out that it cost 2½ times as much to supply a unit to a consumer who used his light on the average one hour per day as it did to another who used it three hours. It was far easier, in his opinion, to reduce the average cost of producing electricity by improving the load factor than attempting to make the same reduction by economising coal. It was also the small householder and his shopping districts which afforded a more promising field for electricity supply than the residential quarters of the rich, and he pointed out that one of the most important corollaries from this theory of the cost of electricity was that streets could be lighted by electricity cheaper than by any other form of illuminant of the same candle-power, and probably the cost per unit for supplying this class of consumer and basements would not much exceed 1½d.

DISCUSSION.

Mr. H. Mavor said he agreed with Mr. Wright's paper, and strongly supported the differential rate of charge. He had devised

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a method with which, although simple, he was not entirely satisfied. He took the total units used per annum and divided them by the total number of lamps installed. This gave the average hours each lamp was used. The charges were then varied by giving the following discounts: lamps used 1,000 hours, 10 per cent.; lamps used 2,000 hours, 20 per cent.; lamps used 3,000 hours, 50 per cent. With this system, profit could be shown when the charge came under 3d. per unit. As regards street-lighting, he thought that arc lamps could not compare with gas as to cost, whereas incandescent light could so compete. Still, it must be borne in mind that a gas plant to supply streets only would not pay at present prices.

Mr. H. M. Sayers, of Bournemouth, said he had adopted the Wright system of maximum-demand indicator, and found by it that the total value of the energy supplied had increased in spite of the reduction of the rate to good consumers. He did not believe Mr. Mavor's system to be at all feasible, as it tended to prevent the complete wiring of premises. At Bournemouth he found the cost of supplying an extra unit to be $\frac{4}{10}$d., including all standing charges. Again, at Bournemouth the maximum demand in 1894 was 168 amperes at 2,000 volts, while in 1895 it was only 163 amperes, although the units supplied had increased 18 per cent. Some 40 consumers who got substantial credit notes had taken 24·6 per cent. more units.

Mr. Alexander Siemens said the differential rate was most satisfactory and fair to the consumer. He regretted that he had not had time to read the paper thoroughly. In his own house he had installed the light everywhere, and had to pay 8d. per unit. The price of gas previously used had been 3s. per thousand, and he had found that the bills for gas and electric light fairly compared, and with all accessory illuminants added did not vary appreciably—in fact, the bill for electric light was slightly under that of gas. He did not see how wall plugs would be reckoned on the Mavor system. The great feature in a private house tending to keep the electric light bill down was that of having the switches placed handy so that the light could be switched off as one leaves the room.

Mr. A Ellis, of Bolton, said he had introduced a maximum demand system at Southport which had been most successful. He charged 7d. per unit for the first two hours' supply, and 4d. per unit afterwards. It had answered so well that now they charged all units after one hour's supply at 4d. The result had been an increase of 18 per cent. in the revenue.

Mr. C. H. Wordingham, of Manchester, claimed that the practice of charging a differential rate was first introduced at Manchester. They made a fixed charge per lamp per annum, and then charged the supply at 2d. per unit. This, however, discouraged the complete wiring of premises. He did not agree with Mr. Wright that all wages should be reckoned as standing charges.

Mr. Dawbarn believed that the load-factor was a most important point in the determination of fair charge. He thought there should be a unit for this quantity called the "Wright."

Mr. W. Geipel laid great stress on the importance of keeping the first cost low, and pointed out that if the cost per kilowatt at Brighton, which was some £125, was reduced to £50 per kilowatt, as at Leicester, the standing charges constants in the paper would be largely reduced. He thought too much money was often spent in steam-pipes and in condensing plant. He also thought that Liverpool could claim the lead in the matter of differential charges.

Mr. Faraday Proctor, of Bristol, thought that the maximum-demand indicator did not meet all the requirements of the case, as it took no account of the time when the load occurred. He believed in encouraging rather the day load, as the extra cost then was least. He did not consider Mr. Sayers's figures as to the effect of the maximum-demand indicator conclusive, as the same effect was found at Bristol, where these indicators were not used. He had used the Kapp meter for differentiating the day and night loads. By this one-third of the current was shunted past the meter in the daytime. The only objection of this was that the total unit supplied was not indicated.

Mr. Hammond dealt largely with the costs of production, and said the principle that Mr. Wright laid down was a very important one for the industry. Mr. Wright told them they should not divide their costs with their total number of units and apply that figure, as they found it in one of the technical papers called *Lightning* that had been referred to, where they found that the total cost and the cost per unit were so much. Without wishing to detract from the value of these figures, he would point out with regard to them that they were simply a reproduction of the Board of Trade returns. With this apology for the tables, he said they found them very misleading. It was misleading to say with regard to Hastings that its cost of production was 3·88 Well, now, the directors of the Hastings company were offered some arc lighting, and they found it could not be produced under 2·5, so they said they could not take it because their average cost was 3·88. He should advise them to take it at the price, because it could be done far below the average cost, which they thought was the cost of supply. They owed a great debt to Mr. Wright that he had drawn attention to the fact that it was erroneous to say that the arc lighting had been carried on at a loss, and that the incandescent light had got to bear the loss on the arc lighting. In making their comparisons of cost between one works and another they had not taken into account the cost of producing the extra units. In Brighton in 1894, as compared with 1893, the cost of producing extra units was 1·33 per unit as compared with the total cost of production 1·81, and it was by taking the cost of the additions that they really got at the cost of production. He could not follow the president in the way in which they should divide it. He agreed with Mr. Wordingham that it was not fair to put on the running charges only a portion of the coal bill, etc.

Mr. Andrews (Hastings) said for the past two or three years they had been getting £25 per lamp annually. That meant that they had received £1,300, and the capital outlay on lamps had been £6,500. They paid 6 per cent. for their money, and allowing 4 per cent. for depreciation, that made a total of 10 per cent. on the capital outlay, which must be deducted from the £6,500. Carbons, trimming, etc., cost £350 a year, so that in the end they had £300 for the 110,000 units, and they could not possibly supply it at that. He had had some difficulty with regard to the charge, but he had adopted a system similar to Mr. Wright's. Each consumer would be charged a uniform price—6d. per unit for all current, and an additional charge of 1s. per lamp per quarter for each 8-c.p. lamp demanded, but the demand must be indicated.

Reply to Discussion.

The **President** replied briefly to the discussion, and said his fuller reply would appear in the *Proceedings*. With regard to Mr. Mavor, Mr. Wordingham had pointed out that there was a very great "nigger" in the system he suggested, and he gave an illustration where a man only had to burn a very little more to get a big reduction in his bill. A system which permitted that was undoubtedly wrong. He was very glad to see that Mr. Sayers had found the running cost per unit to be ·8d., which it was the object of the paper to advocate. With regard to Mr. Siemens's discovery that 8d. a unit was practically equivalent in a house to gas at 3s., he should like to point out that 4½d. per unit would eventually become universal, and would prove how utterly gas was out of it if the 3s. gas was equal to electricity at 8d. a unit. Perhaps Mr. Ellis would state in his written notes whether the lower charge would reduce the profit. With regard to debiting the whole of the wages to standing cost, that was a question of stations, and it was very easily determinable whether this system was right by the analysis he had proposed. At Brighton they found that for three years their wages charges did not diminish in May compared to January. That was the test. This was the result of experience, but any station could test it and find out whether the wages were less in the three lightest months of the year than in the three heaviest. He knew his salary was not less in May than it was in December, and with regard to his clerks they had as much correspondence and meter reading in January as in December. With regard to the wages again, he did not see what he could do with his men. He could not send them away as the load went off. Mr. Hammond seemed to imply that the wages load varied in proportion to the ampere load. If they divided the total amount of wages in the three heaviest months by the difference of units, that would give them the running cost of wages. He wanted to get rid of arbitrary assessment in the matter of cost. With regard to Mr. Dawbarn, he would give the figures he suggested in his written reply. He quite agreed with Mr. Geipel as to keeping capital down first, but he lost sight of the fact that they must take into account the miles of streets supplied by electricity. In Leicester the cost per kilowatt was much less than at Brighton. At Brighton there were 85 miles of mains, and he did not suppose there were so many at Leicester. They must take the area of the district supplied in estimating the capital cost; and the capital cost per kilowatt was not sufficient. It ought to be capital cost per kilowatt multiplied by the miles of streets supplied, and, therefore, Mr. Geipel's deductions as to the alterations in this curve due to lower capital cost would be slightly modified if they took the number of miles of streets supplied. Mr. Proctor suggested that the cost of supplying electricity in the daytime was less than at night, because there were no capital charges to provide for; but why should they not charge day consumers with the station charges as much as the night consumers? Why should they not debit the day consumers with the cost of continuing to run? They could not supply them without capital. [**Mr. Proctor:** If they got day consumers their capital charges would be reduced all round.] In conclusion, the president said their time was very limited, and he would reply further to the discussion and Mr. Andrews in the *Proceedings*. At Hastings it seemed that they studied their items much more carefully than they did elsewhere.

Mr. Andrews: I wish they didn't.

Cable Specifications and Tests.

This was the title of the paper written by Mr. Joseph A. Jeckell, borough electrical engineer, South Shields. The author said he was of opinion that it was fairer and better both for contractors and corporations if it was clearly stated in the specifications exactly what cable was required, and the tests could then be more conveniently specified. Tinned copper wire having 100 per cent. conductivity could now be obtained. The best way to get over the difficulties of difference between the conductive resistance of cables was to specify the resistance the cable has to have, and the number of strands of which it is to be composed, leaving it to the manufacturerers to put in 100 or 98 per cent. of copper as they liked. If a concentric cable was required, care should be taken to specify that the copper resistance of the outer conductor should be the same as the inner. High insulation was not necessary *per se*, but it was necessary in the

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case of rubber cables to ensure good material and workmanship. The pressure test was advisable in all cables, but more especially compound ones. The bending test was advisable in specifications for compound cables. With regard to the laying of cable mains, he felt it was an advantage that the makers should lay their own, but should not do the trench work, which would be more conveniently done by the corporation. Whatever tests were specified as having to be conducted at the maker's works should be repeated as far as possible after the cables had been laid and jointed up. The insulation tests would be made after one month's electrification, but there was no reason for this generally accepted time limit. It was advisable, but awkward at times, to obtain a long time guarantee.

DISCUSSION.

Mr. Wordingham said the mains were the vital part of the electric lighting system, and therefore they must have them all in good order. Although they wanted a good system of mains, they not only wanted a good article, but a cheap one, and they should give manufacturers an opportunity of showing the best they could do. They must have a perfectly definite specification. If they wanted rubber they must specify for rubber, and if they wanted anything else they must specify it. The material, if it was good of its kind, must have an exceedingly high resistance. If the insulation resistance was low, it was bad; but if it was high, it did not necessarily follow that it was also good. He did not attach much importance to insulation tests (although he acknowledged that they were necessary), in so far as they showed that the rubber was bad. They ought to have mechanical tests with all cables. It was perfectly easy to get a bad cable with a high resistance. He did not quite agree that it did not matter what the purity of the copper was, because if they had to put in more material to get a higher resistance they would have a heavier cable. As to stranding altering the resistance of the cable, no doubt it did; if the copper was well in contact it lowered it, but if the strands were insulated, more or less, then it would increase it. As to pressure tests, he thought the small end from the cable should be subjected to a breakdown test and then that a moderately high pressure should be put on the cable itself.

Mr. A. B. Mountain, of Huddersfield, said that in certain cases the contractors could not be responsible for damage. Thus, where faults occurred in street boxes or manholes, he believed that most of the faults in cables were caused by the drawing-in process, and considered that lead-covered cables laid direct in the ground were the safest.

Mr. Hardie McLean, of Oxford, was of opinion that the resident engineer should superintend the drawing-in process and thus find the faults as they were caused.

Mr. H. Talbot, of Nottingham, believed in the guarantee system. He had some £8,000 worth of cables laid in Nottingham three years ago, and still held some £800 of the contractors' money. If contractors would thus guarantee their work, the municipalities were safeguarded.

Mr. Alexander Siemens, speaking from a consumer's point of view, commended Mr. Jeckell on his excellent paper, which, however, did not go quite far enough. The author spoke of rubber and impregnated jute cables as if they were the only types of cables existing. We were indebted to a representative of one of the fire insurance offices for the demand for pure rubber cables, as the pure rubber next to the copper enabled the manufacturer to obtain easily the unnecessarily high insulation resistance demanded. Pure rubber had been proved to be most unserviceable and unable to withstand alternate wetting and drying, as often required in practice. Of course, for house wiring those objectionable conditions did not apply. He thought much damage had been done to the industry by the crazy desire for extremely high insulation resistance. Still, it must be remembered that pure rubber on the cables raised their price, and hence the maker's profit. Greater stress, he thought, should be laid on the uniformity of the insulation used. Another instance he noticed in the paper was that the author recommended cables of 5,000 megohms per mile without specifying the size of the cable. That was useless and unscientific. Impregnated jute cables gave satisfactory results, but generally could not withstand a spark discharge so well as the rubber. He gave an example of a cable in the Charing Cross-road which had stood 2,400 volts for the last five years, but which when installed could not take 3,000 volts without sparking across. His firm, in search after a non-hydroscopic insulator, had produced a material which, when placed on a ·25 square inch cable to a thickness of $\frac{3}{32}$in., stood a pressure of 60,000 volts for half an hour. By the Board of Trade regulations this thickness should only stand 7,500 volts. It was afterwards wrapped round a bar of 3in. radius several times and straightened out again without injury as it stood 50,000 volts after it. The after processes consisted of stripping the lead off, wetting, baking, and boiling without breaking the cable down under 50,000 volts. He believed that all specifications should contain a clause for suggestion on the part of the contractor and for alternative tenders.

Mr. Stuart Russell did not consider that the insulation test was of great value, except as a means of showing how the mechanical treatment of laying affected the electrical condition of the cable. He would also emphasise the value of uniformity in the insulation as a guide to the selection of good cables.

Mr. W. Arnot agreed that the specification of the insulation resistance per mile without giving the dimensions of the cables was absurd. In an old specification he had seen it stated that the insulation resistance of $\frac{1}{4}$ square inch cable should be 2,500 megohms and that of a $\frac{1}{2}$ square inch cable should be 5,000 megohms, which were the converse of what should be. He thought the resistance per mile should be specified rather than the section of the copper.

Mr. Nesbitt said the paper before them was an excellent one. He thought a fourth class of engineers should be added to those enumerated by the author—*i.e*, those who did not care what they had so long as it did what they wanted it to do. He, too, believed that lead-covered cables laid directly in the earth were the most reliable. The thickness of the lead covering had not been referred to, and it was an important subject, as corrosion often took place. Mr. A. H. Preece specified that the thickness of the lead should be a certain definite proportion of the diameter of the finished cable over the lead. As regarded paper cables, they had supplied some low-tension cables to Manchester to stand 100 volts, these had a thickness of only ·07in. insulation and had stood 10,000 volts after being wrapped round a 2ft. barrel and straightened out again.

Mr. T. Callender objected to engineers specifying definitely what they wanted and then taking something else. The engineer should be bound over to take what he had specified, or to insert a clause giving the contractor option to send in an alternative price. He agreed that there could be a great difference of resistance between the inner and outer conductor of a concentric cable due to outer conductors not being in contact. Under the Board of Trade regulations a wire smaller than 20 gauge could not be used, hence this want of contact was bound to occur. As regards the durability of pure cables, he had supplied some to Mr. Crompton in 1882, which he believed had given satisfaction ever since and been in constant use. He approved of Mr. W. H. Preece's specification of specific resistance of the insulating material used. He thought that more attention should be paid to the quality of the material used in the armouring of cables.

Mr. R. E. Crompton believed that the main cause of failure in cables was that of chemical action. This was especially so in vulcanised cables, where a slight modification of vulcanising process seemed to make all the difference between a good and bad cable. He thought that the experience gained in tropical countries was most useful in this respect, as the trying nature of climatic conditions accelerated the faults. He thought they would get help from the cable manufacturers in drawing up their specifications, and could assure the meeting that the cables referred to by Mr. Callender had given no trouble.

Mr. Raworth said that Mr. Jeckell had drawn out the manufacturer in a wholly unexpected way. That was the first meeting he had ever attended in which the cable manufacturer had given any information. He personally believed in specifying the quality of the insulating material in resistance "per acre of 1in. thickness."

The reply to this discussion will be given by Mr. Jeckell in writing, as the time at the disposal of the meeting had practically lapsed.

Electricity Works Records.

The paper by Mr. A. B. MOUNTAIN, A.M.I.E.E., borough electrical engineer, Huddersfield, on this subject was next taken. In this paper the author said he only attempted to give an idea of the chief records required. Some such records must be kept by almost every engineer, and in certain electricity works the necessary clerical assistance was not provided, so that the engineers had not the means of getting the items of expenditure in detail which enabled them to make comparisons with other works. The forms illustrated in the paper were the general records that were absolutely required in the works. The cost-sheet showed the several items to be recorded for one month's expenditure. The time-sheet showed the time of any man, and the cost of such time and the work on which he was employed. The engine-room cost-sheet would give the details required from the engine-room, with the general stores required and the chief points which it was desirable to have a record of. There were also tables to give records of high and low tension mains and plant testing, and a daily log-book, a line-test record, and a consumers' register. There were many engineers, said Mr. Mountain, who had devoted considerable time to the matter of keeping these records and tests, and he thought it would be very desirable for the executive committee to obtain further information as to how electricity accounts should be kept so that a comparison between works might be more accurately made. He suggested that it would be better to get a committee appointed to go into the matter, and bring up again at the next convention a more complete form covering the whole of the points in connection with the subject of his paper. He moved a resolution to that effect.—Mr. STEWART seconded, and said he thought it was a subject well worth enquiring into.—The resolution was agreed to.

(Continued on page 659.)

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MUNICIPAL ELECTRICAL ENGINEERS.

One of the ablest of municipal electrical engineers, discussing the questions of the most important information required by this branch of the profession and the best way in which they could serve each other, contended that it was in the consideration and explanation of details. The broad principles of central-station design are fairly well known, but each station has certain details characteristic of itself, the examination of which will stamp the engineer as original and capable or fashionable and incompetent. There is no need to disguise facts which are well known, for already some of the engineers have placed themselves a head and shoulders above others, mainly because the first class know their work—are able men with original ideas; while the second class fear to proceed upon their own responsibility, and have to consult others in times of difficulty. The same thing holds good in every branch of every profession, so that there is no singularity in finding the condition amongst electrical engineers. It has been also found among other professional men that associations for the purpose of reading and discussing professional papers and the periodic meeting of members conduce to a levelling up process, whereby the average type of the professional man is raised. The benefits that accrue from such an association are both direct and indirect. The direct action is in the direction of raising salaries. The better the men the wider their experience, and the greater their knowledge the easier can they command higher salaries. It pays the employer to give a higher salary to the better man, because he thereby gets his work turned out more cheaply. He saves more in better organisation and attention to details than he pays in higher salaries. This is the human way of looking at the matter, and it is no good pretending that men will go out of their way and spend time and money in making themselves more valuable to their employer without a hope of adequate return. We then assume it proved that associations of this kind do increase the average value of men's work, and that they are better paid for the services rendered. So far as we have been able to gather, this first convention (why not call it meeting?) has produced a number of good papers and excellent discussions. Nothing previously, for example, has brought out so clearly the arguments for and against 220-volt lamps, or the position of municipalities in regard to internal fittings. As regards the former question, its want of flexibility is its principal opposing force, in that it does not lend itself to the general use of lamps of small candle-power, while such lamps are held to be necessary to enable suppliers to compete with gas. The supporters of the higher pressure may, on the other hand, say that the makers of lamps will probably find a way out of their difficulty, and that, assuming the move to be in the right direction, the lamps will be forthcoming when it is found they must be. They contend that finality is not reached even in the making of incandescent lamps. So the matter rests at present. If any maker can satisfactorily provide lamps of small candle-power, there seems to be little doubt but

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that many stations would quickly adopt the higher pressure. The second question mentioned is one of exceeding difficulty. We do not think powers will ever be given to permit of house-to-house supervision and dictation, and we are of opinion that the resolutions proposed by Mr. Wordingham, however desirable from one point of view, will lead the new association into difficulties which at the present time they would do well to avoid. Let us just glance at one point which has probably been overlooked by the members. They are in the position of being officers in places where the electric light has been adopted. They little know the difficulties encountered by those go-ahead members of town councils who desire their towns to adopt the light. By introducing any system of dictation and espionage these difficulties will be increased, and ratepayers will have their backs set up to oppose tooth and nail any attempt to municipalise the light. It is the interest of the profession generally to avoid everything that may tend to prevent an increased rate of progress. But we will not dwell upon the matter. Another subject admirably debated was that of cables. Almost all, if not quite all, the makers were represented, and probably the discussion elicited in a shorter time more information of a practical character than has ever been given before. We must congratulate the association upon its successful meeting.

MUNICIPAL ELECTRICAL ASSOCIATION.

(Concluded from page 657.)

DISCUSSION.

Mr. McLean then proceeded to criticise the paper. He said there was no mention in it as to goods taken back to the store which had previously been taken from it. In the revenue account no details were given as to the different items of revenue. The author gave the total at the end of the month, but did not tell them how his revenue was got—whether from arcs, from charging, from accumulators, or from incandescent lighting. All these points ought to be made quite clear. He did not think it was a good idea to have so many small forms when they could have in their engine-room one form to include them all. There were some forms that were not mentioned in the paper, notably a comparison sheet for the consumers, which he thought would be very useful. The author made a good point when he said that the mains should be entered in such detail that the cost of any extension might be at hand for ready refesence. In conclusion, he said he would forward to the committee one or two forms useful in getting out the list of records.

Mr. Wordingham thought the only possible way of showing the mains was on large maps. He did not think that simply recording the length from box to box was of very much use as a record. He did not think it was possible to have a weekly record of expenses. They did not incur them weekly, neither did they pay them weekly.

Mr. Jackson suggested that in these various records, both public and private, a little more attention should be paid to the units generated.

Mr. Hammond thought this was essentially a paper to be discussed in committee. The matter was one of the very greatest importance, and he should be glad to place his set of books at the disposal of the committee.

REPLY TO THE DISCUSSION.

Mr. Mountain briefly replied to the discussion, and said he thought it was not necessary for him to go into all the points now that the matter would be considered by a committee. In a paper like this he did not think he could have gone into every detail; he only touched upon the more important, and therefore several were left out. It would be noticed that in the engine-room cost-sheet he had mentioned ashes. He thought that it was a very important point. In Brighton, for example, they were paying a good deal for coal, and it was very good and with little ash. In the North, where they got it much cheaper, it was of a common quality and made a lot of ashes.

This concluded the morning business, and the meeting adjourned.

Visit to Islington.

The afternoon meeting was held in the Vestry Hall, Islington, where Mr. VARLEY, in the absence of Mr. Lambert (the chairman of the Electric Lighting Committee), received the members with a congratulatory speech on the successful programme they were getting through. The vestry hall, however, was not so convenient for the meeting as the theatre of the United Service Institution, and the street noises prevented certain speeches from being heard. The first paper was by Mr. John Hesketh, A.M.I.C.E., M.I.E.E., electrical engineer to the Queensland Government, late borough electrical engineer, Blackpool, and Mr. John H. Rider, A.M.I.C.E., M.I.E.E., borough electrical engineer, Plymouth, on

Combined Electric Lighting and Traction Plant.

Mr. RIDER stated that he felt his position keenly, as his partner in the paper had been compelled to leave the country, though he was happy to say, not for this country's good, but for his own. The most important question dealt with in this paper was that of increasing the day load in the electric lighting station by supplying tramways with the current they required. The undertaking would thus reap the benefit of having a certain amount of the standing charges spread over the two departments, and the plant could be available for the double purpose. He referred to the Continental practice and to the towns which had already adopted the combination of electric light and traction plant. In the paper two systems were suggested—the first to have one station containing two distinct plants and to economise coal and the staff required; the other to use the lighting machinery to supply the tramways, and to provide for the overlapping demand by accumulators. The first would tend to increase the peak of total output, while the other would enable the engineer to level up the curve considerably.

DISCUSSION.

Mr. Gay, of Islington, was the first speaker, and he congratulated the authors on the excellency of their paper. The great advantage of the day load so obtained by traction demand could not be over-estimated, but he did not think the plan feasible in London. The Board of Trade would not allow a vestry to supply outside its own area, and the number of authorities therefore concerned in the running of a tramway system would prejudice the smooth working of the same. Still, in provincial towns the extra demand would be of great value, and enable the gas interest to be even more keenly fought than at present. If a special plant and special staff were required he could not see such a great saving, but he thought that motor transformers with heavy flywheels would enable the lighting machinery to be employed. Even then he was not sure that the fluctuation of load would not affect the pressure on the lighting mains. He did not think that storage batteries would be able to stand the sudden and heavy fluctuations without deterioration.

Mr. S. Z. de Ferranti agreed with the last speaker that the difficulties in introducing the combined working in London would be very great. In provincial towns the difficulty would be only in electrical matters, which could be overcome. Still, at Manchester, where they had 440 volts across the outer mains, he doubted if trams could be supplied from these mains without affecting the lighting service. Motor transformers with heavy flywheels would, he thought, overcome this difficulty, and accumulators would also assist. If the original supply was by alternating currents, non-synchronous motors should be used to give the transformers a range of speed, and these motors should not be designed to give too strong a drag for a slight variation of speed. The advantages would be very great, as practically 14 hours' heavy load could be added to the present lighting load.

Mr. C. H. Wordingham agreed with Mr. Ferranti that the traction work could not be supplied by the same mains at Manchester. This was specially debarred, as the centre wire of the five-wire system was earthed, so that two trolleys would have to be used, as an earth return would not be possible. He did not believe in saddling the system with inefficient constant-current transformers, but advised the use of distinct generating plants supplied from the same boilers as the lighting machinery.

Mr. E. Manville thought it would be difficult to overcome the divided interests existing in London, but it was not so in the provinces. He was concerned in two undertakings where they had guarantees of heavy day loads before the stations were opened. The first was at Shoreditch, where the Vestry will supply some half a million units per annum to an underground railway company at the low rate of 1½d. per unit. This was only a day load, as the supply would be discontinued when the ordinary lighting load came on the station. Again, at Swansea the Corporation had agreed to supply the local tramway company with current at the following rates: the total amount per annum

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to be not less than 400,000 units nor more than 750,000 units, at a price varying from 2d. to 1½d. per unit. This load would be continuous, and would be supplied during the heavy lighting loads by stationary accumulators. He referred to the Hamburg station, where the tramways were supplied by the electric light company with six million units per annum at 1d. per unit. The total cost of generation of this amount was ·710d per unit, and the remaining fraction covered the interest and depreciation on the plant.

Mr. W. Arnot could not see the objection to the different London vestries each supplying the trams in their own parishes if the charge was by meter. He also had seen the Hamburg station when his committee made their memorable tour of inspection There the direct-current generators at 600 volts, direct coupled to triple-expansion engines were used for the traction work, and similar machines at 390 volts for lighting purposes on the three-wire system. Two of these 300-volt machines were connected in series if the traction plant was pressed. Separate feeders and mains were used for each purpose, and he did not think it possible to combine the two sets of mains without upsetting the lighting pressure.

Mr. Philip Dawson said there was no objection on the tram way engineer's part to the suggested combined working so long as the distribution was kept separate. At Rome where alternate currents were used, batteries were employed to take the load where the two supplies overlapped. He thought that the corporations supplying traction work from their electric light stations should be bound under comparatively heavy penalties to give a regular and constant supply. Storage batteries in the station could well be used to take the load at times if they were provided amply large.

Mr. Jacobs said that the batteries at Rome had given satisfaction, and the current taken from them varied from 20 to 400 amperes, as the gradients in some parts were very steep, going up to 1 in 12. He thought a flywheel might be put on the motor transformer, which might help the sudden leads, and which, however, did not hurt the accumulators. He considered that secondary batteries should be more used in light circuits to prevent small fluctuations.

Mr. Higginbottom said there had been a good deal of debate in Manchester as to whether they should use their electric light station for traction purposes, and one thing only had been decided, which was that the trams should be worked by electricity.

Mr. Mordey said that the last time he heard the authors of the paper speak on the subject Mr. Hesketh said that he had given up all ideas of getting a decent day load, and was turning his attention to perfecting an arrangement by which the very small day load could be economically supplied. He understood that Mr. Rider had put in batteries with a small alternate-current transformer to take this day load at Bolton. He was glad to see that they were again taking up the subject. He considered that two sets of plant must be used to meet the great fluctuations He then explained the great advantage the alternate-current motor had over the direct-current as regards ease in preventing a large starting current, and regretted that the alternate-current motor at the present time was not sufficiently advanced to be easily applicable to traction purposes. He would also point out that the use of motor generators on the supply stations in London would enable them not only to work a general system of tramlines, but also would assist each other in the lighting loads in case of breakdown.

Alderman Ellis, of Portsmouth, said that they had a scheme for combined working under consideration, and proposed to charge 1½d. per unit for traction supply.

Mr. Wilkinson stated that his experience of similar work in Canada showed that the two systems of feeders must be kept totally distinct. He would point out that the motor generators in sub-stations helped to meet the Board of Trade requirements as to drop in the return circuit. The density of this current in America often gave rise to various inconveniences. He was not at all sure that sufficient flywheel action could be obtained to prevent the reaction on the engines through the transformers if both traction power and light were supplied off one machine.

Mr. Pearson, of Bristol, as chairman of the Electric Lighting Committee, regarded with jealousy any other suppliers of electric energy in his district. At Bristol he had recommended that the Council take the matter up and supply all tramway extensions from their station. Unfortunately, the Council would not go to that length, but they decided to consult Mr. W. H. Preece on the subject, and he opposed extension of the electric tramways until they had his report on the subject. He had taken great interest in all electric questions, and keenly felt that he had only up to the present discovered his own ignorance of this subject He thought that the sooner his *confrères* on the Corporation shared his feeling of ignorance the better. They had at Bristol allowed ample room for the traction machinery in their extensions. He hoped the scientist would help them in some such way to transform science into sovereigns for the benefit of the ratepayers, as unless the ratepayer was pleased the speaker might lose his opportunity to continue his electrical studies. Still, it was a purely business matter, and if the electric light stations could not supply the tractive power more cheaply than could be done by a separate power station, it would be most unfair to force them to take the supply.

Mr. Ruthven Murray remarked that they had a good day load at Worcester, and that the chairman of the Electric Light Committee had done everything to encourage this load. Unfortunately the price charged—only 1d. per unit—was too small to admit of profitable working, and a considerable amount of money was lost last year on this account.

A Gentleman from Liverpool then addressed a few remarks to those around him, and he was inaudible on the other side of the room.

REPLY TO DISCUSSION.

Mr. Rider, in the course of a brief reply, gave Mr. Ferranti the credit of introducing the flywheel on the motor transformer shaft, which he first heard of about a year ago. [We believe Mr. Kapp proposed the same idea in a debate before the Civil Engineers in 1893.—ED. *E. E.*] Mr. Rider also pointed out that nothing in the paper would suggest that their system of mains would do for both electric lighting and traction purposes. Mr. Hesketh and himself had no idea of making that suggestion when they wrote their paper.

On the Organisation of an Electricity Works Staff.

Mr. E. T. RUTHVEN MURRAY, city electrical engineer, Worcester, read the following abstract on this subject: As the success of an electricity works depends in no small degree upon the staff directly engaged in running the plant, the organisation of this staff requires considerable judgment on the part of those responsible for their engagement. It behoves the engineer to be particularly careful and far-seeing in engaging a staff to keep the wages item of the standing charges as low as is consistent with safety, since when the output is small this item is a heavy burden on the young station. No hard-and-fast rules can be laid down as to the number of men necessary on the staff, as this will depend upon the individual characteristics of the electricity works. Among other matters to be considered which have a direct bearing upon this are the size of the works, their designs, the system employed, whether a direct-current battery station or an alternating-current supply, and, of course, whether the supply is constant or intermittent. Unless there be a large demand throughout the night for public lighting, or an intermittent demand both by day and by night for motors, the small battery station may be able to give a constant supply with only one watch of men, whereas the alternating-current station will require three eight-hour watches. How many men are required for a watch will depend upon the size of the works; but probably it will be necessary to have at least one engineer in charge, one driver, and one fireman. Regarding assistant engineers, it seems only right and proper to employ them, as one can hardly expect either the engine-drivers or switchboard attendants to have the necessary technical training to enable them to take entire charge of the works during the absence of the chief engineer; moreover, it is obviously necessary to give some one man the general responsibility of the proper working of the station during each watch. In organising the staff, it is most important that the engineer be allowed to choose or recommend men for appointment, and that the men know to whom they are responsible. It is the greatest mistake for the committee who have charge of the department not to allow their chief engineer a free hand in this respect, and internal troubles in electricity works have often been due to this cause.

DISCUSSION.

Mr. Albert Gay considered the subject was too much affected by local conditions to admit of general conclusions. The reduction of the staff should not be pushed to extremes, as a stand-by should be provided. Longer hours and two shifts instead of three did not mean a saving, as the men would demand overtime after eight hours at the rate of time and a half. He considered eight hours amply long enough for any man to work in an electric light station. He did not believe in fitter-drivers, and thought one man to spare should always be provided in the all-night shift in case of sudden illness on the part of any one man.

Mr. Dawbarn advised that electrical connection should be made from the station to the houses of the officials and men, as was now the case with fire stations, but his remarks did not obtain the approval of the resident engineers, who objected to be called every time a gauge glass or a fuse went.

Mr. J. F. L. Crosland asserted that the firemen should be most carefully selected, and that the idea that any man was fitted to put coals into a furnace was very erroneous From his experience of boiler work he would say that nothing was more detrimental to the boilers or wasteful in fuel than employing inefficient stokers. The same remark as to inefficiency applied, of course, also to engine-drivers.

Mr. Arnot contended that the staff should all be under the direct control of the engineer-in chief, and that the committee should exert no influence in this matter. He had seen the fruits of an engineer being obliged to employ the inefficient and insubordinate friend of an individual committeeman.

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Mr. A. B. Mountain advocated the continuity of policy with the staff, and always preferred to train up youths for the subordinate positions. He believed in having pupils who could take a shift when required, and in educating his own meter men, etc., and at the same time paying them a fair wage.

Alderman Higginbottom said that at Manchester they had fought out this trouble, and after some inconvenience had left the matter for six months in Dr. John Hopkinson's hands. He had sent them their present engineer, Mr. Wordingham, for the time and since then matters had been left entirely in the latter gentleman's hands. All but the second and third engineers were responsible only to the chief engineer, and the system had worked admirably.

Alderman Norman supported the above view, and said that no one on his committee would dream of interfering with the authority of their engineer over his staff.

Alderman Pearson did not agree with the last two speakers. The Electric Lighting Committee were alone responsible to the Corporation, and, as chairman, he would not waive his rights under this responsibility. He of course would not in any way interfere with the duties of his respected resident engineer in the selection of the staff in the ordinary way. The fact of the appointment being finally in the hands of the committee rather strengthened the engineer's position when an inefficient man was recommended by some member of the Corporation. He would then be relieved of the personal refusal, which otherwise might lead to trouble.

REPLY TO THE DISCUSSION.

Mr. Ruthven Murray replied that he had not recommended a reduction of the staff, but rather wished to point out the minimum staff which would be required in one watch in a new electric light station. He also had only advocated the use of the fitter-driver in the early stages, when the output at the station did not warrant a larger staff.

The meeting then terminated, and arrangements were made for certain of the members to go over the Bankside station of the City of London Electric Lighting Company, and also over the Davies-street station, after they had inspected the works at Islington.

A vote of thanks was passed by acclamation to Mr. Varley for his kindness in presiding, and also to the Islington Vestry for lending their hall for the purposes of the meeting.

To-day (Friday) a general meeting of members and associates will be held, after which a visit will be made to Brighton, where the convention will terminate.

ELECTRIC AND MAGNETIC RESEARCH AT LOW TEMPERATURES.*

BY J. A. FLEMING, M.A., D.SC., F.R.S., M.R.I.

During the last four years much time has been spent by Prof. Dewar and by me in the prosecution of a joint research on the principal electric and magnetic properties of metals at very low temperatures. Some reference has already been made in previous discourses by Prof. Dewar to portions of this work,† but the special object of the present lecture is to extend these descriptions, and put you in possession of the latest results in this department of the low-temperature investigations. It will be convenient to discuss the several divisions of it in the order in which they have engaged our attention.

One hundred and sixty-seven years ago, Stephen Gray, pensioner of the Charterhouse, in conjunction with his friend Granvile Wheler, stretched a packthread 300ft. long over silk supports and demonstrated that an electrification of the thread at one end spread instantly over the whole mass, but that if metal wires replaced the silk no electrification of the thread was possible. This experiment undoubtedly formed the starting point for the first definite recognition of the necessity for a classification of bodies into insulators and conductors, a distinction which Gray's brilliant contemporary, Dufay, extended and confirmed, and for which he and Desaguiliers coined these familiar terms.‡ Gray's contributions to knowledge as an epoch-making discoverer have received less notice from scientific historians than their real value deserves. It is less easy to state who first noticed that the powers of conduction and insulation were greatly affected by temperature. Cavendish in 1776, however, was perfectly familiar with the fact that warm solutions of salt conduct electricity better than cold,* and made measurements of the relative resistances of an iron wire and a salt solution marvellously accurate when we consider that his means of measurement was the comparison of electric shocks taken through the bodies to be examined.

Not until after the invention of the battery and galvanometer was it clearly proved that differences exist between the conducting powers of metals; but by Davy, Becquerel, Ohm, Pouillet, Fechner, and others all the fundamental facts were ascertained, and the classical researches of Wheatstone and, later, of Matthiessen gave us the accurate laws and constants of electrical conduction. By these investigations it was shown that in the case of electric conduction through metallic wires of uniform sectional area their total resistance was proportional to the length inversely as the cross-section, and also proportional to a specific constant for each material called its *resistivity*. Moreover, it was found that this resistivity was considerably affected by temperature, generally being increased in metals by rise of temperature and decreased for carbon, electrolytic liquids, and many badly-conducting bodies.

Although much knowledge of the behaviour of pure metals and alloys in regard to electric conduction has thus been accumulated, we considered that it would be of great scientific interest to examine with care the changes occurring in the conductivity of these bodies, or reciprocally in their resistivity, when cooled to temperatures of 200deg. or more below the Centigrade zero by the aid of liquid oxygen and liquid air.† Knowing the great influence of very small quantities of impurity on this quality, our first attention was directed to obtaining samples of alloys and metals in a state of great chemical purity, in giving to wires drawn from them a suitable form, and in devising a convenient support, or holder, by which the electrical resistance of the wire might be measured when immersed in liquid oxygen or liquid air, either in quiet ebullition in an open vessel or under reduced pressure in a closed one. It will be unnecessary to dwell on difficulties surrounding the preparation of these accurately-drawn metallic wires of pure metals. Suffice it to say that our obligations to Mr. George Matthey, Mr. Edward Matthey, Mr. J. W. Swan, and other friends were very great with respect to this portion of the work. The final outcome of all failures was the production of a resistance coil of the following form: Two thick wires of high-conductivity copper about 3mm. or 4mm. thick are bent, as shown in Fig. 1, and wrapped round the lower part

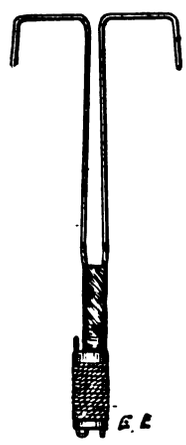

FIG. 1.

with a cylindrical sheath of thin vulcanised fibre laced to them by a silk thread. On this sheath, which generally had the form of an oval cylinder, a paraffined silk cord was spirally wound so as to leave a helical groove. In this groove was coiled the resistance wire of known length and section, and its ends were attached by solder to the ends of the thick copper leads. The wire was wound a little loosely in the groove so as to allow for the great contraction which takes place on cooling, and yet the wire was exposed so as to take up instantly the temperature of the bath, whilst at the same time the mass of material to be cooled down was rendered as small as possible. The length of wire employed was generally about one or two metres, and the diameter from about one-twelfth to half a millimetre (·003in. to ·02in.). These mean diameters were measured by the microscope micrometer at about 50 to 100 places for each metre length of the wire. Having thus prepared a great collection of resistance coils of pure metals and alloys each in the form of a wire

* A Friday evening discourse delivered at the Royal Institution, June 5, 1896. Lord Kelvin in the chair.

† "Scientific Uses of Liquid Air." A Friday evening discourse by Prof. J. Dewar, LL.D., F.R.S., delivered at the Royal Institution, January 19, 1894.

‡ See "The Intellectual Rise in Electricity," by Park Benjamin. Stephen Gray's papers on this subject communicated to the Royal Society are as follows: *Phil. Transactions*, 1720, vol. 31, p. 104; 1731, vol. 37, p. 18; 1732, vol. 37, p. 285; 1735, vol. 39, p. 16; 1736 vol. 39, p. 400. See also Dufay, *Phil. Trans.*, 1733, No. 431, p. 258.

* See "The Electrical Researches of Cavendish," edited by Clerk Maxwell, p. 324.

† Almost the only experimental work previously done in this subject seems to have been that of Cailletel and Bontz (*Journal de Physique*, July, 1885) on the resistance of metals at – 100deg. C., using ethylene as a refrigerating agent, and a research by Wroblewski on the resistance of copper at very low temperatures (*Comptes Rendus*, 1885, vol. ci., p. 161).

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of known length and mean diameter, the next operation was the measurement of their resistance at definite temperatures. For the sake of those not fully familiar with the details of electrical measurement, a moment's digression may be made to explain two of the principal methods in use. Becquerel's work was chiefly conducted with the differential galvanometer. In this instrument two coils of wire of exactly equal length are coiled on one bobbin, in the centre of which hangs a small magnetic needle. The current from a battery divides at one point and flows along one path through the conductor under examination and through one coil of the galvanometer. The other portion of the current flows through a wire of variable length, called a rheostat, and through the other coil of the galvanometer, equal in every respect to the first coil, but circulates round the needle in an opposite direction to that of the current in the first coil. Hence, if the currents are of equal strength, the needle is not disturbed at all from its zero position. We can make these currents equal by adjusting the length of the wire of the rheostat so that its resistance is equal to the resistance of the coil being tested. By this means it is easy to verify all the ordinary laws of conduction. We can, for instance, show at once that by warming an iron wire in hot oil its resistance is increased, whereas in warming the carbon filament of an incandescent lamp its resistance is decreased.

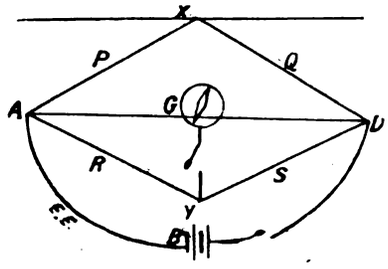

FIG. 2.

This method is not generally so convenient as the arrangement first described by Mr. Hunter Christie to the Royal Society in 1833, redevised 10 years later by Wheatstone, in 1843, and which has been always curiously misnamed the "Wheatstone's bridge," even in spite of Wheatstone's own declaration that he did not invent it.* In this arrangement (see Fig. 2) the current from a battery, B, has two paths open to it by which to complete its circuit, and we employ a galvanometer with a single coil to discover two points on these two circuits which are at equal potentials. When these two points are connected the galvanometer needle is undisturbed, and it is a simple matter to show that under these circumstances the numerical values of the electrical resistances of the segments of the two circuits are to one another in simple proportion—that is, P is to Q as R is to S. In actual work, one form which this arrangement takes is that known as the slide-wire bridge (see Figs. 3 and 4), and which is before you. In this construction the battery current flows partly through a uniform wire stretched over a scale and partly through a standard resistance, S, and the resistance, R, to be tested placed in parallel with it. We employ a galvanometer to connect the middle point between R and S with some point on the slide wire, and we can always find a point on the slide wire such that no current flows through the galvanometer. The ratio of the unknown resistance, R, is to that of the known standard resistance, S, in the ratio of the lengths of the two sections into which the contact-piece divides the slide wire. Hence, R is determined in terms of S. Another form of this appliance, in which all three arms of the bridge consist of coils of wire capable of being joined in series with each other by plugs, is most commonly used, and it was a most carefully adjusted Elliott bridge of this last pattern which we employed.

All our resistance measurements have been reduced to express them in terms of the international ohm as defined by the Board of Trade Committee and obtained by reference to standard coils carefully standardised for us at Cambridge. By this means the whole of our wires were measured at five definite temperatures—viz., at about 200deg. C.; at the temperature of boiling water, 100deg. C.; at the temperature of melting ice, 0deg. C.; at the temperature of solid carbonic acid melting in ether, which gives a temperature of about 78deg. C.; and at the temperature of liquid oxygen boiling under a pressure of 760mm., which gives a temperature at − 185deg. C. In this last case the coils were immersed in liquid oxygen contained in suitable vacuum-jacketed vessels. In this connection I should like to express with due emphasis the opinion that none of this low-temperature research would have been possible at all without the assistance of Prof. Dewar's most valuable invention, the glass vacuum-jacketed silvered vessel. For much of this work it has been necessary to employ many litres of liquid oxygen and air at a time and to be able to keep it for hours in a state of perfect quiescence and absolutely constant temperature, and in no way could this have been done without this beautiful and scientific device.

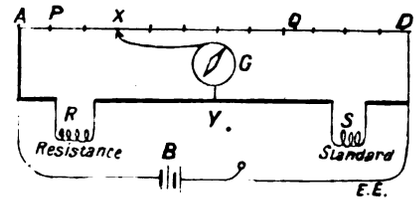

FIG. 4.

Before describing the results of these experiments it may be interesting to exhibit a few of the principal facts. The most striking of them is the very great reduction in electrical resistance or increase in conductivity experienced by all the pure metals when cooled in liquid air. Here, for instance, are two coils of iron wire. Balancing them on the bridge, we find them to be of exactly equal resistance; but if one of the coils is cooled in liquid air, its resistance is reduced to about one-tenth of its resistance at the ordinary temperature of the air. We may also compare the resistance of these two similar iron coils when one is placed in boiling liquid air and the other in boiling water. The resistances, instead of being in the ratio of 2 to 1, are now in the ratio of 1 to 12. Again, if we take two wires, one of pure iron and one of pure copper, of exactly equal length and equal section, we find that at ordinary temperatures (15deg. C.) the iron wire has about six times the resistance of the copper; but if we cool down the iron wire in liquid air to 186deg. C., still keeping the copper coil at the ordinary temperature (15deg. C.), we now find that the iron coil has actually become a much better conductor (about 30 per cent. better) than the copper.* On the other hand, if we examine the behaviour of this coil of German silver, which is a copper-zinc-nickel alloy, or of this platinum-silver coil, we find that the cooling through 200deg. has but little effect upon its electrical resistance. We thus see that whilst pure metals have their electrical resistance immensely decreased by cooling to the temperature of liquid air, alloys generally do not experience anything like so great a change. A word or two must next be said on the manner in

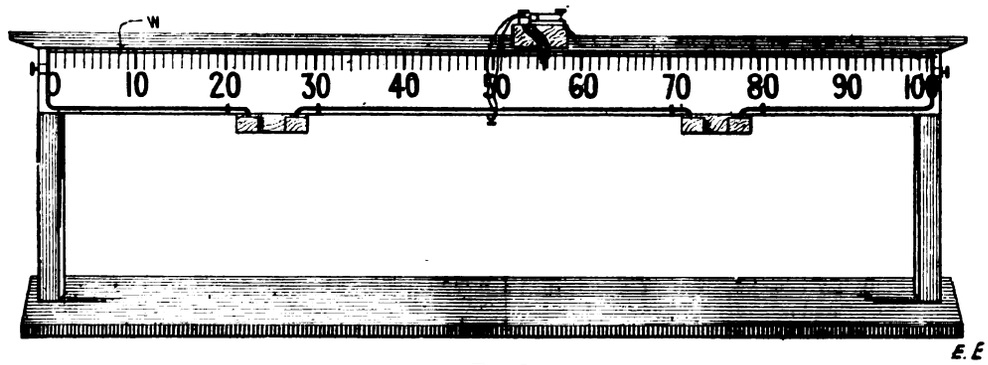

FIG. 3.

* See *Phil. Trans.*, 1833: Mr. S. Hunter Christie on "The Experimental Determination of the Laws of Magneto-Electric Induction." See also Wheatstone's "Scientific Papers," p. 129, "An Account of Several New Instruments for Determining the Constants of a Voltaic Circuit" (*Phil. Trans*, vol. 133, p. 303, 1843).

* The exact resistances of the coils used for the experiment were as follows: Iron at 16deg. C. = 7·003 ohms and reduces to 0·711 ohm at − 186deg. C. Copper at 16deg. = 1·169 ohms; reduces to 0·2033 at − 186deg. C.

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which we have represented graphically all the results of our experiments. We desired to delineate lines on a chart so as to express the change in specific resistance of all our metals and alloys in terms of temperature, and the question then arises, How was the temperature measured? You already know that an ordinary thermometer, whether mercury, alcohol, or air, would be useless to measure temperature at temperatures at which even air liquefies under ordinary pressure.

The employment of the constant-pressure hydrogen thermometer with reduced pressure would have given us temperature readings very approximately those of the absolute thermodynamic scale, but the experimental difficulties of its use would have been enormous. We preferred to use the platinum resistance thermometer and to express our temperatures in platinum degrees, as follows. Our experience has shown us that a pure, soft annealed platinum wire may be cooled as often as necessary to the lowest attainable temperatures, and yet will always have the same resistance when measured again at other constant temperatures. Availing ourselves of this fact, we have used in all this work a low-temperature platinum thermometer made in the following way: A well-annealed platinum wire is made into a resistance coil, as already described. Its resistance is carefully measured at the temperature of boiling water (100deg. C.) and melting ice (0deg. C.). From these measurements we construct a scale of temperature as follows: A horizontal line (see Fig. 5) is taken on which to mark off temperature, and any two points are taken on this line and divided into 100 equal parts. At these extreme points perpendiculars are set up proportional to the resistance of the platinum wire at 0deg. C. and 100deg. C. respectively, and through the tops of these perpendiculars a sloping straight line is drawn until it cuts the axis of temperature. The graduation of the horizontal line is continued in both directions on the same scale as the sub-division of the line between the points marked 0 and 100. To measure and define any other temperature—say, for instance, the boiling point of liquid oxygen under a pressure of 760mm.—

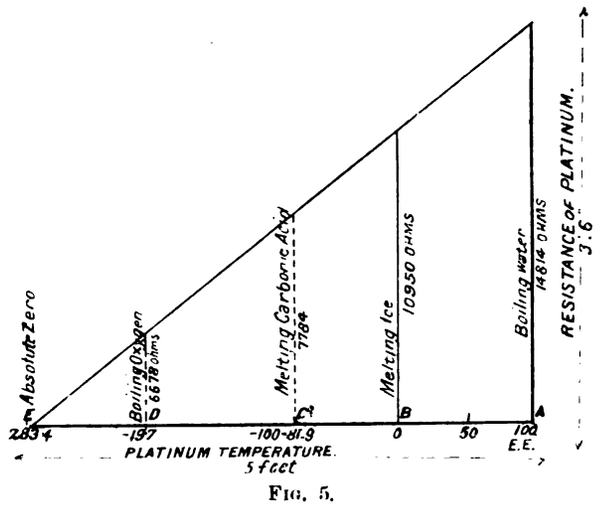

FIG. 5.

we have simply to measure the resistance of the platinum wire in the oxygen. We then look out on the chart the ordinate which has the same numerical value as the resistance of the wire in the oxygen, and at the foot of that ordinate we find a number—viz., (−197)—which is the temperature of the liquid oxygen on this platinum scale. Two questions then arise: first, Do all annealed platinum wires give, when used in this way, the same numerical values for definite and identical temperatures? The answer to this is, Nearly, but not quite. In the case of two thermometers much used by us the difference was about half a degree at −100deg. C., the boiling point of liquid ethylene. Into this matter it is not possible here to enter more fully; suffice it to say that we have invariably reduced our temperature measurements to one standard thermometer. The second question is equally important; it is, What is the relation of the scale of temperature so defined to the absolute thermodynamic scale, or, which is very nearly the same thing, to the scale of temperature defined by a constant-pressure hydrogen thermometer? If the air thermometer and platinum thermometer readings are made to agree at 0deg. C. and 100deg. C., then a temperature which would be called 50deg. on the Centigrade scale would be denoted by 50·4 (nearly) on the platinum thermometer scale, and corresponding to the −78deg. on the Centigrade scale, which is the temperature of carbonic acid melting in ether. The platinum temperature by our standard is −81°·9, and corresponding to −182deg. C., which is very nearly the Centigrade temperature of liquid oxygen boiling at the normal pressure of 760mm.; the platinum temperature by the same standard is −197deg. The conversion of these numbers representing low temperatures in platinum degrees into the numbers representing the corresponding absolute thermodynamic temperatures is a work we have reserved for a future research*, but meanwhile it may be said that there is no method of measuring low temperatures which is so easy of application and so accurate as that depending on the use of a platinum thermometer. All our work has been ultimately referred to one standard platinum thermometer, which we call P_1. A suggestion may here be made. There is no reason why the Board of Trade electrical laboratory should not possess a standard platinum thermometer defining officially platinum temperatures, or absolute, for all time, and with which other platinum thermometers could be easily and very accurately compared.

(To be continued.)

AN ANALYSIS OF TRANSFORMER CURVES.†

BY CHARLES J. HUGUET.

This paper describes a number of experiments in regard to the distortion of primary current curves on open secondary. This was one of the most noteworthy features of Prof. Ryan's paper on "Transformers," read before the institute, and Prof. Ryan ascribed this distortion to hysteresis. The same opinion seems to have been held by Fleming, Steinmetz, and every other writer since that time, with the single exception of Prof. Rowland.

Dr. Sumpner had previously shown that, assuming hysteresis absent, a variation in the value of the permeability will superpose on the sinoidal magnetising current a system of higher harmonics, causing it to become a symmetrically peaked curve. Prof. Rowland, however, went further, and declared that the presence of the distorting harmonics is due, not to hysteresis, but to change in permeability, the effect of hysteresis being capable of representation as a simple resistance. However, he simply expressed this theory mathematically without giving any experimental verification, and it is doubtless for this reason that the results of this paper have not been accepted in their entirety. This apparent conflict of opinion seemed to warrant further investigation, and it was the object of experiments conducted by the writer at Tulane University in June, 1895, to throw light on this question by analysing the current curve into its various components.

The method employed in the measurement of the instantaneous values was essentially similar to the telephone method described by Prof. Nichols in his "Laboratory Manual," a galvanometer being substituted for the telephone. Runs were made at different voltages and rates of alternations from which the data were sufficient to discriminate the eddy from the hysteresis losses. By dividing the watts lost by eddies by the E.M.F. applied, the effective current due to eddies is obtained, and the ratio of this to the aforesaid E.M.F. is the conductance due to eddies.

If the instantaneous values of E.M.F. be multiplied by this conductance, and the resulting eddy-current curve be subtracted from the original current curve, the remainder will be the hysteresis curve—*i.e.*, the curve that would be derived from the hysteresis loop. If in the same way we determine the conductance due to both eddies and hysteresis—*i.e.*, if we represent the hysteretic loss as one due to a simple constant resistance, and subtract the effective current curve thus determined from the original current, the remainder will be a true wattless current, since the curve subtracted itself accounts for the watts lost. The wattless remainder is very fairly symmetrical with respect to the flux curve, and is of the peaked character to be expected with permeability variable and hysteresis absent. A similar treatment of Prof. Ryan's curve yielded a wattless remainder of similar character. These results seemed to verify Prof. Rowland's theory, at least approximately. But equally strong proof is afforded by several curves in the paper of Steinmetz, "On the Laws of Hysteresis" (Part III.).

The writer concludes that for sinoidal E.M.F.: (1) Hysteresis may in all respects be replaced by a constant resistance if the hysteretic characteristic be the quadrant of an ellipse. (2) This condition is approximately satisfied

* Callendar has shown that over a wide range of temperature, from 0deg. C. to 700deg C., the difference between the platinum temperature and the air thermometer temperature is a parabolic function of the absolute temperature.

† Read before the American Institute of Electrical Engineers, May 20, 1896. Abstracted by the *Electrical Engineer* (New York).

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for moderate ranges of magnetisation (such as are used in practice), in reasonably good iron, and the higher harmonics are negligible. There will usually be a particular range that will give a nearly perfect approximation. On contraction of the range, the hysteretic current becomes more pointed than the sine, and on expansion beyond the critical range more flattened than the sine. (3) The increased distortion of the hysteretic current for higher ranges will cause an increase in the higher harmonics, but the rapid diminution in the permeability on approaching saturation will cause a much greater increase in these harmonics, so that even at higher ranges the distorting influence of hysteresis is comparatively slight.

As a final conclusion, then, we may say that Prof. Rowland's hypothesis that the higher harmonics in the transformer for sinoidal E.M.F.'s are due, not to hysteresis, but to variation in permeability, and that the effect of hysteresis may be represented by a constant resistance, is approximately correct, for reasonably good iron, is very nearly correct for the moderate ranges used in practice, and may, under certain conditions, be absolutely correct.

RESULTS ACCOMPLISHED IN DISTRIBUTION OF LIGHT AND POWER BY ALTERNATING CURRENTS.*

BY W. L. R. EMMET.

(Concluded from page 634.)

Fig. 6 shows diagrammatically the distribution of voltage with a given balance load on a two-phase four-wire circuit, and on the same circuit with one wire discarded, the third being used as a common return for the two sides of the system. S F and E G represent the two generated voltages on the four-wire two-phase system. F F′ and G G′ represent the E.M.F.'s of self-induction in the lines of the separate two-wire branches of the circuit. F′ F″, G′ G″ represent the resistance drop in the two branches. E F″ and E G″, which are still at right angles, represent the two voltages at the end of the line. The other diagram in Fig. 6 shows the condition on the three wire circuit. A B and A C represent the generated voltages in quadrature.

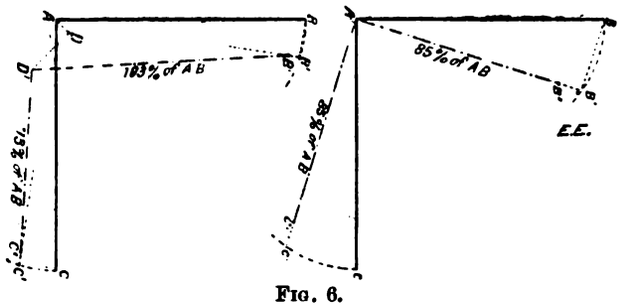

FIG. 6.

C C′ and B B′ represent the volts of self-induction in the outside conductors. C′ C″ and B′ B″ represent the volts' drop by resistance in these wires. A D is the resistance drop in the third wire and D D′ is the E.M.F. of self-induction in the third wire. Since this wire carries 40 per cent. more current than the others, A D is 42 per cent. greater than C′ C″, and B′ B″ and D D′ bear the same proportion to C C′, and B B′. The length of D′ B″ and D′ C″ represents the voltages on the two sides of the system at the end of the line. The angle C′ D′ B″ is the phase relation of these two circuits, and is less than 90deg. Thus with balanced load the sides of the system are neither equal or in quadrature.

The figures are so proportioned as to represent a circuit of "O O" B. & S. wire operated at 125 cycles with 10 per cent. resistance drop on the four-wire system, and the same load and the same distance with three wires. With 1,000 volts at the generator in both of these cases, we would have 850 volts on each side with the four-wire system, and with the three-wire system 730 volts on one side and 1,030 on the other. This assumes aerial lines with ordinary spacing of wires. In addition to the systems above described for distributing power by induction motors, we have other means of power distribution by alternating current. The synchronous motor, for certain classes of work, is highly efficient and reliable, and is extensively used, although it will not fill all the requirements of general power distribution. The rotary converter also fills a very important place in the engineering work of the day.

A synchronous motor is simply an alternating dynamo whose functions are reversed. They may be used either on single-phase or polyphase circuits. In its simple form, a synchronous motor has no power of starting itself on a single-phase circuit. On a polyphase circuit it starts with more or less torque as an induction motor, and will come to synchronism. As a rule, the starting of synchronous motors is not vigorous, and is accomplished by a large draught of current; hence their applications are limited. A rotary converter is a synchronous motor of suitable construction, whose armature windings, besides being connected to collector rings, are also connected to a commutator. As the machine revolves at synchronous speed, brushes collect direct current from the commutator, this current being partly rectified and partly generated by the machine. This machine deals in direct and alternating currents and mechanical power; supply it with any one of the three, it will deliver either one or both of the others. It is most efficient when filling its functions as a converter from alternating to direct currents. Its capacity is then greater and its efficiency higher than when it runs as a generator or as a motor.

To illustrate the use of the rotary converter, I will describe an application now under consideration. The company in question is operating three stations. One of these is very large and centrally situated, with condensing water and every facility for the cheap generation of current. Each of the other stations is about two miles from the main station; both work non-condensing. One of these stations delivers current only on the direct-current three-wire system, while the other, in addition to similar work, carries a considerable arc light load. In this case the following plan is considered:

At the two smaller stations rotary converters would be installed, and would deliver only direct current in one case, while in the other they would also act as motors to operate arc machines through a countershaft, to which they would be belted with clutch pulleys. Suitable step-down transformers would connect the rotary converters to a high-tension line leading to the main station. At the same station three-phase generators of large capacity would be installed. These generators would be designed to deliver both three-phase alternating currents to step-up transformers and also direct currents at about 250 volts to the outside conductors of the three-wire system. They would be directly coupled to engines. These machines would deliver current simultaneously, in any proportion, to the direct-current three-wire system, to the rotary converter, or to lines distributing three-phase power. It is proposed to operate these machines at a frequency of 25 cycles per second, this being well adapted to the direct-current work and also to three-phase power distribution. In this plant an entirely independent control of direct-current pressure within a wide range would be necessary at the main and sub-stations. This would be effected without the introduction of idle currents by the use of a novel form of three-phase induction regulator connected to the alternating leads of each rotary converter. These regulators would give a wide range of adjustment without any moving connections, and would greatly simplify the operation of the plant, and also increase its economy, since the losses introduced by the regulators themselves are very small, and since conditions of general economy are always maintained. Thus a single engine could carry the whole load of the city at certain times.

Another interesting illustration of a combination of alternating and direct currents is found in a case now under consideration. A company controls about 3,000 h.p. in water at a distance of 11 miles from a large town. It is proposed to instal three-phase 60-cycle generators in 600-kilowatt units. The current from these generators will be transformed to 10,000 volts and carried over three wires to a city sub-station centrally placed. Here large step-down transformers will be installed, delivering current to

* Paper read before the Nineteenth Convention of the National Electric Light Association, May 5, 6, and 7, 1896.

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2,000-volt lines, which extend all over the city and carry motors and lights in outlying parts. In the same station two large Corliss engines are now in operation, and are belted to clutch pulleys on a countershaft, which operates some arc machines and other load. To this countershaft it is proposed to couple with a clutch a large synchronous motor which will be connected to the 2,000-volt lines. When the water supply is ample, the engines will be shut down and the motor will run the shaft. When the water is low, or more power is required, the engines will be run and the synchronous motor will then act as a generator, running in parallel with the transmission line. In the central part of the town it is proposed to instal a system of three wire mains and a large storage battery. This battery would be installed in a second sub-station, conveniently placed. It would be charged from a pair of direct-current machines, directly coupled to a synchronous motor operating from the 2,000-volt lines. The direct-current machines would be used in connection with the batteries for supplying the three-wire system. The plan here outlined has many very positive advantages.

The pressure on the 2,000-volt system can, within certain limits, be controlled at the sub-station by adjustments of the field of the synchronous motor. With telephone communication to the power-house, the control will be perfectly easy. The peak of the lighting load being borne by the battery, the generators can be loaded nearly to their full capacity with motors during the day. At night they will charge batteries, using water which would otherwise run to waste. In both the plants described the cost of labour would be very small, one man being enough to operate each of the sub-stations mentioned. The saving of labour in operation should be kept constantly in view in all engineering plans. Some of the greatest advantages in modern apparatus lie in its adaptability to such saving.

An infinite variety of conditions exists in different cities, and the question of electrical distribution must be carefully studied in each case in order that money may be invested to the best advantage. An intimate knowledge, both of the apparatus available and of the commercial conditions, is necessary to an intelligent decision in such cases. It is only through the exercise of intelligence and judgment of a high order that the best results can be obtained.

LEGAL INTELLIGENCE.

THE SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

In the Chancery Division on Tuesday, Mr. Justice Romer gave judgment in the case of the Electric Construction Corporation *v* South Staffordshire Tramways Company, which came before the Court at the latter end of April, and occupied five days in the hearing. The action was brought to recover certain sums due under an agreement dated February, 1892, and the defence set up was that the Court could not enforce specific performance. The defendants further counterclaimed that the agreement was not binding upon them, asking for rescission and relief by way of damages.

Mr. Eve, Q C., and Mr. Theobald were for the plaintiffs; and Sir F. Lockwood, Mr. Oswald, Q C., Mr. C. E. E. Jenkins, and Mr. T. D. Munns were for the defendants.

His **Lordship** said that, seeing how disastrously to the defendants the contract in question had resulted, he was not surprised that the shareholders should view it with reluctance, and endeavour, if possible, to escape from its provisions, and, having regard to the way in which the defendants had been, as it would appear, defrauded by their officer, Wain, and their solicitor, Ebbsmith, that they should imagine it was brought about by sinister influences and dishonest purposes, and that it was not in the true interests of the defendant company. But the contract had been carried out by the plaintiffs, and ought not to be set aside unless the defendants established a case that would justify the Court in refusing to hold it binding upon them. That the defendants had not done to his satisfaction, and, notwithstanding his sympathy with the company, he must hold the contract binding upon the defendants. The main defence was that the contract was fraudulently brought about, and was unfairly onerous on the defendants and impossible to be carried out by them. It was also suggested that the contract was *ultra vires* of the defendants, but no sufficient reason for this had been shown. The defendants also relied on the fact that debentures were parted with by the defendants before the plaintiffs had made any payments or done any work under the contract. But, although that might have shown imprudence, it could not be laid hold of as invalidating the contract after the plaintiffs had made the payments and done the work contracted to be made and done by them. As their main contention the defendants had broadly urged that the contract was brought about as part of a far-reaching fraudulent scheme of Wain and Ebbsmith, but they had not established that the contract was fraudulent or fraudulently brought about by Wain and Ebbsmith or by any other person or persons. Its terms were the subject of careful consideration by both companies and of considerable negotiations, which had been fairly and honestly conducted. The contract was not a profitable one for the plaintiffs, and, although it was onerous on the defendants, they could not have inaugurated a system of electric working without aid or without entering into some such contract. The defendants were advised in the matter by their engineer, Mr. Dickinson, a gentleman of great experience and skill, and, notwithstanding the reflections which had been made on him on behalf of the defendants, his Lordship saw no sufficient reason for holding that Mr. Dickinson did not honestly advise them at the time. The only provision in the contract to which strong objection could be made was that enabling the plaintiffs to bring the agreement to an end if the then directors of the defendant company, or any of them should, otherwise than by death or voluntary resignation, cease to be directors. But at this time the frauds of Wain were not known, he being then generally recognised as a gentleman of high character and of great experience and skill as a tramway expert. The provision might have worked very hardly against the defendants but it had not been acted on, and it was impossible, therefore, to make the existence of this provision a ground for upsetting the contract. As regarded Clause 3, his Lordship said he did not think the payments made to Mr. Dickinson were a bribe to him. There was no ground for thinking Mr. Dickinson did not fairly do his duty by the defendants. The defendants said that as the cost to the plaintiffs of working the electric tramways was about 3d a mile, the 4½d. mentioned in Clause 16 was excessive, but if the plaintiffs had been obliged to exercise the power given to them by Clause 16 of bringing the agreement to an end the risk and loss to them would or might have been very great, and his Lordship thought the 4½d. might fairly be taken as a sum properly compensating them under the circumstances. His Lordship accordingly declared the contract binding on the defendants, and that under Clause 16 it was ended on December 14, 1894 and on that footing he directed the account to be taken, the defendants undertaking to account for all costs occasioned by them. He would adjourn further consideration to chambers, with liberty to apply and with liberty to apply generally. As to the costs up to and including trial, the defendants must pay the plaintiffs' costs of the action. The counterclaim wholly failed, except as to the sums the plaintiffs had undertaken to account for; he therefore ordered the defendants to pay the costs of the counterclaim, except so far as they had been increased by the plaintiffs not admitting the sums to be accounted for by them, and in respect to those he ordered the plaintiffs to pay them and for them to be a set off.

Mr. Oswald said that as this was a matter of life and death to the defendant company, he would ask for a stay of execution, if the appeal was brought in reasonable time

Mr. Justice Romer then directed the account to proceed; but if taken before appeal was heard, gave liberty to apply again.

ELECTRIC LIGHTING AT EXETER.

In the Chancery Division of the High Court last week, before Mr. Justice North the case of Franklin and Gould *v.* the Exeter Electric Lighting Company, Limited, was heard.

Mr. Jenkins, for the plaintiffs, the trustees for the debenture-holders in the company, said the company had entered into an agreement with the Exeter Corporation for the sale of their undertaking to the Corporation for £7,500, which agreement would take effect on 30th inst. The only assets of the company cutside this sale to the Corporation consisted of book debts and a few chattels, amounting altogether to about £1,000, so that the whole assets of the company amounted to £8 500 As the debentures amounted to £12,000 there was a considerable shortage. The company was in difficulties, and there were debts which it could not pay. One of the unsecured creditors was suing the company, and the debenture-holders' trustees had brought this action to enforce the security under the debenture deed and to ask for the appointment of a Mr. Knill as receiver with power to manage until the sale to the Corporation was carried into effect.

Mr. Broughton Edge said he was instructed to offer no opposition on behalf of the company.

Judgment was given for the plaintiffs for the amount of the security, Mr. Knill being appointed receiver and manager of the company, with power to act at once.

COMPANIES' MEETINGS AND REPORTS.

ELECTRIC TRACTION COMPANY, LIMITED.

An ordinary general meeting of this Company was held on Friday at 16, Great George street, Westminster, Mr. R. E. Farrant presiding.

The **Chairman**, in moving the adoption of the report, which has already been published in our columns, said that the business of the Company to which the directors were at present devoting their attention was the construction and equipment of the Central London Railway, which would run through the heart of London, from Shepherd's Bush to the City, a distance of 6½ miles. This

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work was undertaken in pursuance of a contract with the railway company, dated June 18, 1895, under which the Traction Company was to acquire the necessary land and to construct and equip the railway with rolling-stock, to be worked by electrical power to the satisfaction of the railway company's engineers, the whole to be completed and delivered by December. 1898. The dominant feature of the report was that, having settled the price to be paid for the bulk of the property to be acquired, and having let the contracts for almost the whole of the heavy work, they were satisfied that the undertaking could be carried out within the original estimates, and they had no reason to doubt, unless something altogether unforeseen occurred, that they would complete the railway within the contract time The stations would be 14 in number, and were placed in the best positions to secure the greatest amount of traffic along the line of route. The Act of Parliament authorising the construction of the line prohibited the making of any openings in the roadways, so that all shafts must be sunk at the station sites Their first work, therefore, was necessarily the acquisition of the property required for the stations and the depôt at Shepherd's Bush. The acquisition of valuable property having frontages on what Mr. J S. Forbes once described as the greatest traffic thoroughfare in the world was by no means a simple matter, because of the many interests involved—freeholders, lessees, sub-lessees tenants, trade interests The work of dealing with these claims had been pushed forward with such energy that at the present time more than four fifths of the total number of claims had been settled or had been adjudicated upon by an arbitrator or a jury. He did not think it expedient to state publicly what these settlements had cost them, for there were still about 20 cases to be dealt with. The land estimates were originally framed some years ago, and since then the cost of investments had increased largely, and they had consequently had to pay very heavily for some of the properties of an investment character. Of course, the settlement of the amount of a claim did not mean that they at once got possession. In about half of the total number of cases the purchases had been completed, and they now had complete possession of three station sites, so that there was nothing on this score to prevent the actual work of construction from being very shortly commenced. The line from Shepherd's Bush to the Bank had been divided into six sections, and it was decided to ask for tenders for each of these separately, and a list of responsible contracting firms was settled with the engineers who should be asked to tender. They had had a good reply to the invitations. and they had given the sub-contracts as follows: Sections 1, 2, and 3 Shepherd's Bush to the Marble Arch Mr. J Price; sections 4 and 5, the Marble Arch to the Post Office, Messrs. Walter Scott and Co.; and section 6, the Post Office to the Bank, Mr. G. Talbot. Shareholders would remember that in connection with the railway there was to be constructed under the open space in front of the Mansion House and the Royal Exchange a system of public subways, which would also give access from the public streets to the Bank Station. The general idea of this system of subways was approved by the City authorities some time ago, but before they could invite tenders for the work the detailed plans had to be settled. This was a work requiring the utmost care and attention, but they had succeeded in presenting plans which secured the acceptance of the Commissioners of Sewers. The sub-contract for this work had been given to Mr. G. Talbot. The station in the vicinity of Davies-street and the extension from the Bank to Liverpool-street were receiving their attention, but he would not dwell on these matters as they were still in the stage of negotiation.

Mr. T. Davidson seconded the adoption of the report, and it was carried unanimously.

The chairman and retiring directors having been re-elected, resolutions confirming the arrangements as to their remuneration were carried without dissent.

IMPROVED ELECTRIC GLOW LAMP COMPANY.

A meeting of this Company was held on Saturday at Cannon-street Hotel, but the Press were not admitted. The improved glow lamp, it may be mentioned, is one in which there is a mirror deposited on the stem portion of the lamp so as to reflect the light downwards.

BOURNEMOUTH AND DISTRICT ELECTRIC SUPPLY COMPANY, LIMITED.

The fifth ordinary general meeting of this Company was held at Bournemouth last week, Mr. Aymor H. Sanderson presiding.

The **Chairman**, in moving the adoption of the report and financial statement, said that the great increase in the use of electric light in Bournemouth was, he thought, due in some measure to the steps taken from time to time by the directors to cheapen and popularise the light, while at the time sparing neither trouble nor expense in order to ensure its quality and reliability. For the purposes of the expansion to which he had made reference he said considerable loans to meet the capital requirements of the Company had been obtained from the County of London and Brush Provincial Electric Lighting Company, Limited, and the time was not far distant when, in the opinion of the directors, it would become advisable to incorporate the amount of these loans into the permanent capital of the Company by readjustment of the capital account. When this took place, Bournemouth investors would be afforded an opportunity of further increasing their interest in the Company. In a well-to-do place like Bournemouth there was no reason why the greater part of the Bournemouth Company's capital should not be held locally, and he thought local investors would do well to embrace the opportunity of subscribing for the Company's shares and debentures when the opportunity was afforded them, so that the Company might continue to be a local company in fact as well as in name.

Dr. J. A Hosker seconded the adoption of the report, and it was unanimously carried.

Dr. Hosker was re-elected a director of the Company, and Mr. R. H. Marsh, chartered accountant, was re elected auditor.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ecija (Spain).—The Municipal Authorities of Ecija want tenders by July 2 for a system of electric lighting for the town.

Cherbourg.—The French Ministry of Marine are asking for tenders, by June 18, for the supply of a quantity of electric fittings.

San Sebastian (Spain).—The San Sebastian Tramway Company ask for tenders, by July 1, for the application of electric traction to their line.

Benevento (Italy).—A concession for installing and working the electric lighting of the town of Benevento is open to be tendered for up to June 20.

Bucharest.—The Municipality want tenders by July 1 for the electric lighting of a portion of the Boulevard Coltzea. The estimate is about £3,680.

Utrera (Spain)—Tenders are wanted by the Municipal Authority of Utrera for the installation of electric lighting. The last date for receipt of tenders is July 1.

Lisbon.—The South and South-East Railway Company, Largo de S. Roque 22, Lisbon, want tenders by June 15 for 12 tons of galvanised iron wire for telegraphs.

London, S.E.—Tenders are required for complete installation of electric lighting. For particulars apply by letter to Mr. H. Freeman, 44, Knatchbull-road, Camberwell, S.E.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years Tenders should be sent in by August 31.

Brussels.—The Belgian Telegraphic Department want tenders for the purchase of old telegraphic instruments and stores (31 lots). Particulars obtainable at the Brussels Bourse, and tenders to be in by June 24.

Spandau.—Tenders are wanted at the Royal Small-Arms Factory for 900 incandescent electric lamps by July 17. Particulars are obtainable for 75pfg. (9d.) from Die Königl. Direktion der Gewehrfabrik (Geschäftszimmer No. 21) Spandau.

Ocana (Spain).—The Ocana Municipal Authorities are open to receive tenders, up to June 30, for the electric lighting and water supply of the town. The annual payment suggested is 10,000 pesetas (about £400). Ocana is in the province of Toledo.

Paris.—Tenders are wanted for the supply of a dynamo for the municipal generating station at the Buttes Chaumont. Application for permission to tender must be made at the Hotel de Ville before June 14, and tenders must be in by June 17.

Brussels.—Tenders will be received shortly (the exact date is not yet announced) at the Brussels Bourse for the material and work necessary to start an electric lighting installation at the fifth section of the central locomotive construction works at Malines.

Brussels.—On June 17 there will be a reallotment of contracts for the conversion to a system of electric traction of about 12½ miles of local light railway. Application for particulars (price 1fr.) should be made to la Société nationale des chemins de fer vicinaux, rue de la Science 28, Brussels.

Paris.—Tenders are wanted by the French Government Telegraphic Department for the supply of about 125 tons of galvanised iron wire, 3,000 cross-pieces (iron), and 100,000 screws and various accessories. Particulars are obtainable at Rue de Grenelle 103, Paris, and application for permission to tender must be made before June 15. Tenders must be in by June 25.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Burnley.—The Corporation invite tenders for the supply and delivery at their electric lighting station, Burnley, of armoured concentric underground cables. Specification, schedule of quantities, and form of tender may be obtained on application to Mr. W R Wright, borough electrical engineer, on payment of £1. 1s., which will be returned on receipt of a *bonâ fide* tender. Sealed tenders, endorsed "Tender for Cables," and addressed to the Chairman of the Electric Lighting Sub-Committee, Town Hall, Burnley, must be delivered on or before the 24th inst.

Huddersfield.—Tenders are required for the supply and erection of a 92-unit direct-current dynamo and of a 3½-unit combined steam-engine and dynamo at Trafalgar Mills, Huddersfield, for Messrs. Learoyd Bros. and Co. Copies of specifications and general conditions can be obtained from Messrs. Shepherd and Watney, engineers, 71, Albion-street, Leeds, on receipt of a cheque for

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£1. 1s., which will be returned on receipt of a bona fide tender. Tenders, endorsed "Electric Lighting," must be addressed and delivered to Messrs. Learoyd Bros. and Co., Milnsbridge, Huddersfield, before noon on 19th inst.

Glasgow.—Tenders are invited by the Caledonian Railway Company for the supply of telegraph and electric appliances, etc., for 12 months from August 1, 1896. Specifications and forms of tender and any other necessary information may be obtained on and after June 1 from Mr. Jas Lorimer, superintendent of stores, Caledonian Railway, Charles-street, St. Rollox, Glasgow. Patterns may be inspected on and after June 1 from 9 a.m. till 5 p.m. at the Company's Stores, Charles-street. St Rollox (Saturdays 9 a.m. till 1 p m.). Tenders, endorsed "Tender for Stores," to be lodged with Mr J. Blackburn, secretary, 302, Buchanan-street, Glasgow, by June 15.

Leeds.—The City Council invite tenders for an electrical installation sufficient for the working by the overhead system of haulage, a double track of tramway seven miles long. The work will be divided into the following contracts: (1) poles for supporting trolley wire; (2) underground conduits and conductors; (3) trolley wire and attachments; (4) motorcars; (5) accumulators and switches; (6) steam engines; (7) dynamos, switchboards, and accessories Tenders, endorsed with the number of the contract, must be sent in, addressed to the Town Clerk, Town Hall, Leeds, by June 22 Particulars, plans, forms of tender may be had (on payment of a deposit of £2 2s. for each contract, which will be returned on receipt of a bona fide tender) from the City Engineer, Municipal Buildings, Leeds; or from Dr. John Hopkinson, F.R S., 5, Victoria-street, Westminster, S W.

Hampstead (London).—Tenders are wanted for the extension of the electric lighting station in the parish stoneyard, Lithos-road, Finchley-road, N W., for the Vestry of St. John, Hampstead. Drawings and specification can be inspected, and bills of quantities and form of tender obtained, on application to Mr. Arthur P. Johnson, vestry clerk, Vestry Hall, Haverstock-hill, Hampstead, N.W., on and after 15th inst., between 10 a.m. and 4 p.m., and upon payment of £2. 2s, which will be returned if a bona fide tender is sent in. The person or firm whose tender is accepted will be required to enter into a written contract and to provide two sureties for the performance of contract. The expenses of contract and bond are to be paid by the contractor. Sealed tenders, endorsed "Tender for Extension of Electric Lighting Station," must be delivered at the vestry clerk's office by 4 p m. on 25th inst.

Shoreditch.—The Vestry invite tenders for the supply and fixing of insulated conduits, cables, switch and fuse boards, and all sundry fittings and materials for installing the electric light in their new dust destructor and electricity supply station, Coronet-street, Shoreditch. Specifications, with forms of tender, can be obtained from the consulting engineers Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of three guineas, which sum will be returned on receipt of a *bonâ fide* tender. Contractors whose tenders are accepted will be required to enter into a formal agreement, under seal, with sufficient sureties for the due fulfilment of their respective contracts. Trade union rates of wages and hours to be observed. Sealed tenders, endorsed "Electric Lighting—Tender for Wiring," to be sent by 4 p.m. on June 16 to Mr. H. Mansfield Robinson, clerk and solicitor, Town Hall, Old-street, E C.

Kingston (Jamaica).—The Colonial Government invite electric tramway contractors willing to undertake the establishment and working of a system of rapid transit to send in applications for the grant of a license by the Governor in Privy Council under the Tramways Law, 1895. In all applications the principal questions to which attention should be directed are the following: (*a*) the amount of capital which the applicants are prepared to subscribe; (*b*) the system which it is proposed to establish; (*c*) the mileage of lines to be laid; (*d*) the fares to be charged; (*e*) the frequency of the service; (*f*) the length of the license required by applicants; (*g*) the guarantee which the applicants offer for the satisfactory performance on their part of any obligations devolving on them. Plans of the city of Kingston and part of the parish of St. Andrew, showing the routes on which the present tramway lines are laid, and copies of the law under which licenses are granted and of the rules made thereunder by the Governor in Privy Council, may be seen at the office of the Crown Agents for the Colonies, Downing-street, London, S.W. All applications must be delivered not later than July 31, 1896, in a sealed packet, marked on the outside "Application for Tramway License," to the clerk of the Privy Council, Kingston, Jamaica. Kingston has its principal means of transit at present supplied by the Jamaica Street Car Company by horse tramcars, the entire length of lines laid being about 12 miles. The concession granted by the Legislature of the island to the Jamaica Street Car Company will shortly expire.

Bucharest.—The result of the enquiry into the tender of contracts held on March 26, 1896, having led to no definite approval, notice is given that a fresh enquiry will be held on June 24, 1896, at 10 a m. in the Town Hall Bucharest, when sealed offers and tenders will be received for the lighting of the outlying zone of the town, by such a system as will not necessitate any canalisation, and which may be adjudged to be most advantageous of all the systems proposed, with a view to replacing the 3,265 petroleum lamps now lighting the streets and squares of the outlying districts of the town The enquiry will take place in accordance with the conditions of contract established by the management of the Public Works Department and approved by the Town Council at its meeting held on January 24, 1896. Particulars of the conditions may be obtained at the offices of the Agence Havas, 96, Queen-street, Cheapside, London, between 11 a.m. and 4 p.m. The contract will be granted for a period of five years dating from the time of its approbation and acceptance by the Board of Enquiry, or for a longer period, according to the proposals and conditions of tenders submitted. Competitors must indicate in their tenders the points provided for in clause 6 of the conditions of contract respectively. Intending competitors are requested to attend on the day and at the hour above mentioned at the Town Hall, prepared with a deposit in 15,000fr. in cash or in Government stock to be placed in the Public Pay Office, in order to be admitted to take part in the competition.

RESULTS OF TENDERS.

Paisley.—The Town Council have accepted the Brush Company's tender for wiring the Clark Town Hall at £844.

Edinburgh.—The tender of Messrs. J. Waldie and Sons for the supply of coal to the electric lighting station has been accepted.

Rochdale.—For installing the electric light at the free library, for the Town Council, the tender of Messrs. Peers and Co., Manchester, has been accepted. The amount is about £500.

Perth.—The offer by Messrs. A. Westwood and Son, Perth, to put up telephones from the gasworks to Princes-street Station, in connection with the working of the oil-gas contract, and the conveyance by the oil-pipe of tar from the works to the station for £17. 18s. has been accepted.

Newington (London).—The tender of Messrs. J. F. Clarke and Sons, 49, Moorgate-street, amounting to £6,579, has been accepted for engineering work and electric lighting at the new public baths and wash-houses in course of erection in Manor-place, Walworth, for the parish of St. Mary's, Newington.

Egremont.—The Wallasey Urban District Council have alloted the contracts for electric lighting requisites as follows: British Insulated Wire Company, Limited, Prescot, Lancs., high and low tension concentric cables; Electric Construction Company, Limited, Wolverhampton, transformers; S Z. de Ferranti, Limited, 27. Charterhouse-square, London, E.C., engines, dynamos, etc. The Council do not make public the amounts of their accepted tenders

Colchester.—The result of the tenders for the electric lighting was given briefly last week. The firms tendering were:

	A.	B.	C.
Brush Company	£12,076 15 0	.. £12,442	.. £186 0 0
Christy Bros.	12,881 0 0	... 13,092	... 187 0 0
Electric Construction Company (accepted).	10,675 0 0	.. 10,940	... 257 10 0
Siemens Bros. and Co... Limited	11,477 0 0	... 11,708	... 375 0 0

A. 80 per cent. on completion, and balance after six months. B. Six months after completion. C. Loan of plant for military hospital The figures under this heading are calculated by the engineers on the assumption that 250 40-watt lamps are used three hours per day for, say, 30 weeks, equalling a demand of 6,300 units.

The following is from the particulars of requirements of the Council and conditions to be observed by the contractors: Each party tendering shall submit a complete scheme and tender for the whole of the plant, machinery, mains, feeders, street work, and everything that may be necessary (except buildings, foundations, and water). The total number of lamps assumed to be wired is 6,000; and although the distributing mains and feeders should be large enough for a maximum demand of 240 kilowatts, the plant and machinery need not at first have a larger working output than 150 kilowatts. Having regard to the compactness of the area to be lighted, and to the amount of private lighting already being carried on in Colchester, it is not thought desirable now to supply current for anything except 110-volt lamps; but it would be well, in view of probable extensions in the neighbourhood of the infantry barracks and in other directions, to take into account the possibility of using a higher pressure hereafter. Parties tendering must state what efficiency in pounds weight per hour of dry steam per Board of Trade unit they would be prepared to guarantee at the dynamo terminals during the last four hours of a 24 hours' test run As the War Office Authorities require current immediately for 250 40 watt lamps (100 volts) at the military hospital, parties tendering should state the terms upon which they would be prepared to lend a suitable temporary plant, and to run it for this purpose, until the permanent works are established. Payment will be made on the joint certificate of the borough engineer, acting for the Council, as follows: either (1) 80 per cent. as soon as the whole of the work has been satisfactorily completed, and the balance six months after; or (2) the whole of the moneys due to the contractors in one sum when the works have been run by them for six months.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,540.

Commercial Cable Company.—The Commercial Cable Company have declared a quarterly dividend of 1¾ per cent. on the capital stock.

Bromyard.—At the meeting of the District Council a draft agreement from the General Post Office for extension of the telegraph to Bishop's Froome was approved.

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Ballymena (Ireland).—A meeting has been held and a deputation appointed to obtain, if possible, telephonic connection between Ballymena and Belfast with a local exchange.

Edinburgh.—Prof. Kennedy's report on the condition of the mains and plant has been published. Prof. Kennedy finds everything satisfactory. We hope to give the report next week.

Fulham (London) —The Vestry's Electric Lighting and Dust Destructor Committee have appointed Mr. W. R. Sayer as chairman and Mr. A. Cook as vice-chairman for the ensuing year.

Canterbury.—Mr R. Hammond, M.I C.E , has been appointed by the Town Council electrical engineer for the installation of the electric light, at a remuneration of 5 per cent. on the total cost of the works.

Cupar (Fife).—The Fife County Road Board have appointed a committee to examine and report in reference to the position of affairs with reference to the Board's contract with the Telephone Company.

Appointment Vacant.—The Electric Lighting Committee of South Shields want an assistant and draughtsman in the electrical engineer's office, at a salary of £100. Applications should be made to the Town Clerk.

Queen Anne Mansions.—The Queen Anne Mansions Electric Light and Heating Company, Limited, is to be absorbed in the newly-registered Queen Anne Residential Mansions and Hotel Company, Limited.

Swansea —The advisability of lighting the market by electricity is being seriously considered by the Corporation, and steps have been taken to ascertain the cost as compared with the existing system of lighting by gas.

Dundee.—The Works Committee have received a report by the burgh engineer upon the question of the twin-wire system of telephony and its probable introduction into Dundee, and deferred consideration of it to next meeting.

City of London Company.—The Board of the City of London Electric Lighting Company, Limited, have declared an interim dividend on the preference shares at the rate of 6 per cent. per annum for the half-year ending June 30.

Crosby.—At a meeting of the Urban District Council, the clerk produced a copy of the Bill in Parliament in reference to the electric lighting of the district, which he reported carried out the terms comprised in the provisional order.

York.—A meeting of the ratepayers has been held for the purpose of protesting against the adoption by the Corporation of an electric lighting system under municipal management, or the financing of any company with the ratepayers' money.

Halstead (Essex).—It has been reported to the Urban District Council that the meeting of the committee had not yet been held to consider the report on electric lighting, as the various members had not been able to fully digest the report on the matter.

Harrogate —At a meeting of the Town Council the electrical engineer was instructed to have the cable laid up Princes street and square to Victoria-avenue, in Albert-street, Market-place, and Cambridge-street, and to prepare a scheme for street-lighting.

Liverpool.—At the meeting of the Mersey Dock Board the proceedings of the Committee of Works, which contained a recommendation to accept a tender for an electric light installation for the new wool warehouse, Great Howard-street, were confirmed.

Carbon Contracts.—In the parliamentary return of contracts for articles of home manufacture made by Government departments last year with contractors outside the United Kingdom, the Admiralty is scheduled for £219 worth of carbons for electric lights.

Brazilian Submarine Telegraph Company.—The directors of the Brazilian Submarine Telegraph Company, Limited, have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ending March 31.

Lahore.—The Municipality are contemplating the lighting of Lahore by electricity. The city and station have been surveyed, and it is probable that a company will be formed to take the work in hand so soon as the Government can secure the necessary legislation.

Ripley.—This town has just been constituted an intermediate telephone call office. The Government having taken over the trunk lines, Ripley has been connected with Nottingham and Mansfield, and will doubtless receive further connections, including Derby.

Wells (Somerset).—The question of the adoption of the electric light was under consideration at a meeting of the Town Council. It was moved that Dr. Hopkinson be instructed to prepare plans and specifications for an installation of the electric light. The resolution was carried.

Ludlow.—At the Town Council meeting considerable correspondence was read on the question of the National Telephone Company and wires across the streets. Mr. T. Roberts moved, and Alderman Weyman seconded, that the wires be removed at once, and this was carried.

Stowmarket.—Through the enterprise of Messrs. Peddar and Prentice, who have erected works and wires in Ipswich-street and the Market-place at Stowmarket, the public and private residents there now have the opportunity of using the light in their business establishments and houses.

Paisley.—The Town Council have decided to appoint a resident electrical engineer at a salary of £200. Several offers of ground for the lighting station have been submitted to the Electric Lighting Committee, but they have decided to let the matter of site lie over till the engineer be appointed.

Eastern Extension, Australasia, and China Telegraph Company.—The directors have declared an interim dividend for the quarter ended March 31 last of 2s. 6d. per share, free of income tax, payable on the 15th prox. The share register will be closed from July 7 to July 14, both days inclusive.

Britannia Motor Company, Limited.—This is a new company formed to take part in the development of the horseless carriage industry, and to acquire the patent rights of the Britannia motor. The purchase price to be paid to the vendor is £50,000, payable as to £10,000 in cash and the balance in shares or cash.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending June 7 amounted to £1,152, as compared with £1,671 in the corresponding week of the previous year, being a decrease of £519. The comparison is, however, only formal, as the corresponding week last year was Whitsuntide.

Morecambe.—At a meeting of the District Council it was resolved that Mr. Thos. Parker, electrical engineer, Wolverhampton, be instructed to prepare the necessary plans, etc., for the proposed public electrical installation, at an estimated cost of £25,000, a site for the works having been provisionally secured.

Telegraph Clerks.—The annual conference in connection with the Postal Telegraph Clerks' Association has been opened at Exeter. Mr. Doyle (Dublin) moved a resolution protesting against the policy of reducing the male and adding to the female establishments of many of the large and small offices. The motion was carried.

Cardiff.—At the Town Council meeting a question arose as to the occasional failure of the electric light at the market in St. Mary-street, and eventually Mr. John Jenkins proposed, Mr. W. Evans seconded, and it was agreed, that a full report of the position should be prepared for presentation to the next meeting of the Council.

City and South London Railway.—The returns for the week ended June 7 were £930, compared with £904 for the corresponding period of last year, being an increase of £26. The total receipts for the half-year terminating as above were £21,465, compared with £21,437 in the same period of the preceding year, being an increase of £28.

Leamington.—At a meeting of the Town Council the report of the Watch and Lighting Committee was read, stating that the committee had asked Mr. Jones (manager of the Midland Electric Lighting Company) to give an estimate for lighting the parade with arc lamps of the pattern of one which they had recently inspected The report was adopted.

Rye —The report of the Technical Instruction Committee states that 13 students joined the electricity class. The students had made excellent attendances. On examination, Mr. Arnold King, reported that the result was creditable to the instructor, and that Mr. Milsom's paper was exceedingly good Three students in the electricity class were awarded certificates.

Birmingham.—The Public Works Committee have sat from 10 o'clock in the morning until nearly four in the afternoon to consider the recent proposals with respect to the renewal of the leases of the lines of the Central Tramways system to a syndicate. The committee determined to communicate nothing to the Press, but it is understood that they came to no decision on the matter.

Rotherhithe.—At the Vestry meeting, on the recommendation of the General Purposes Committee, the Vestry offered no objection, subject to a few minor conditions which had been accepted, to the intention of the London Electric Supply Corporation, Limited, to lay trunk mains in Rotherhithe New-road and Bush-road, in exercise of the powers conferred by their provisional order dated 1889.

Dewsbury (Yorks).—At a meeting of the Town Council it was decided to reduce the charge for electricity for heating and motive power. The electrical engineer was directed to lay mains for the supply of electricity to the Dewsbury and District Technical School at a cost of £540. The Town Council also decided to increase the salary of Mr. J. B. Mitchell, the Corporation electrical engineer, from £175 to £200.

Leeds.—The Tramways Committee have had under consideration the advisability of extending the tramway system in two or three different parts of the city. The feeling of the meeting appeared to be generally in favour of steps being taken to secure the necessary powers for this purpose, and it was resolved to hold a special meeting of the committee at an early date, when it is expected some definite recommendation will be made on the subject.

Whitehaven —The Electric Lighting Committee have reported to the Harbour Commissioners that they had received a letter from Mr. J. S. Brodie, borough engineer, intimating that the electric lights of the harbour would be altered and reduced. The committee agreed, with one dissentient, to allow the suggested alterations to be proceeded with Mr. Black, in moving the adoption of the report, remarked that the lighting had not been altogether satisfactory.

Simla.—*Indian Engineering* says that tenders for lighting the town hall and principal thoroughfares are being daily received by the Municipality, but it is scarcely expected that any will be accepted owing to the cost and to the little encouragement given to the idea by the tradespeople and private individuals. The engine-shed connected with the theatre is nearly completed, and the light will soon be used. This concern is entirely an enterprise of the Simla "A.D.C.," and the Municipality are not in any way responsible.

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Dublin.—The electric tramway appears to be a great success so far as traffic is concerned. The whole of the rolling-stock has been in regular work, and the traffic is daily becoming larger. To meet this the company is already augmenting the rolling stock. Five motorcars will arrive during the week, and 15 more a little later. By the time horse show week comes round there will be 30 trains (60 carriages) of electrical cars at work. This will enable the company to despatch cars from the terminus at two-minute intervals.

Douglas.—Rapid progress is being made with the work of the southern electric tramway from Douglas Head to Port Soderick. It is expected by the promoters that the line will be completed by the early part of July. The date for the opening has been fixed for Saturday, July 4, and it is understood that Lord Kelvin has consented to visit the island for the purpose of inaugurating the electric tramway. It is stated that negotiations are in progress and are almost completed for the purpose of extending the tramway to a point quite close to Port Soderick. The line will be four or five miles in length.

Worcester.—The new Hope-Jones electric organ will shortly be completed in the cathedral One of the features of the electric apparatus is the provision of a "stop-switch," so that any combination of stops and couplers may be prepared in advance and brought into play at the moment desired. In order so far as possible to get expression, the great, swell, and choir keyboards will each be furnished with a "double-touch." The wind will be supplied by a new form of blowing-machine driven by an alternating current electric motor. The air will be drawn from the cathedral, compressed, and then stored in a portion of the crypt till required.

Milwaukee Electric Railway and Light Company.—Some 5,100,000dol. 5 per cent. 30 year consolidated mortgage gold bonds of this Company are to be put on the English market. This is part of a total issue of 7,000,000dol., of which 400,000dol. are in the hands of the public and 1,500,000dol. are retained to cover outstanding bonds. The Company in question is formed by the consolidation of various city railways and lighting companies, and owns and operates all the street railways in the city of Milwaukee. The price of issue is 102 per cent., or £204 per bond of 1,000dol., and the issuing firm is Messrs. J. P. Morgan and Co

Portsmouth.—In future the Portsmouth swimming-bath will be provided with a continuous supply of salt water, new electric motors having been erected for pumping purposes. The Electric Light Committee have decided to recommend the Town Council to purchase a new engine of 1,000 h.p. for the electric light station, and to borrow £10,000 with which to cover the cost of the engine and ot cable required for the extension of the mains. The engine itself is estimated to cost £6,200. The present boiler power will suffice to run this new engine, which will be adequate to meet the increasing wants of private consumers for a considerable time to come.

Tunbridge Wells.—The Town Council have decided to place incandescent electric lamps in Grove Hill-road in lieu of the existgas lamps. The town clerk has been instructed to apply to the lady of the manor for permission to lay mains across parts of the common. The tender of Messrs. Babcock and Wilcox for two large boilers at £543 each, a small one at £264, and a feed-water heater at £147 has been accepted, and tenders invited for the purchase of the present rectifier, to be replaced by a larger one The borough surveyor is preparing a report on the best site for stores and offices at the central station. The buildings are to be insured for £3,000 and the machinery for £4,000.

Simplex Tramway.—Under the title of the Simplex Electric Tramway Conduit Syndicate, Limited, a new company has been registered by T. T. Hull, 22, Chancery-lane, W.C., with a capital of £30,000 in £1 shares (5,000 A and 25,000 B), in order to acquire from J. B. Atherton a certain invention for improvements in the means of and appliances for distributing and collecting electricity for the propulsion of vehicles; to adopt an agreement with the said inventor, and to own and work tramways, railways, etc. The first directors, of whom there shall not be less than three nor more than seven, are E. K. Muspratt, A Adam, T. Snape, and J. B. Atherton. Remuneration, £150 each per annum.

A Lamp Supply Dispute.—At the Westminster County Court, before his Honour Judge Lumley Smith, Q.C., Messrs. Dodge and Fraser, Charing Cross, sued the London and Provincial Supply Corporation, Edgware-road, for £11. 10s. for two arc lamps and some repairs to dynamos on the defendants' premises. When fixed, the lamps did not work because the dynamos were not sufficiently powerful. The defence practically was that the plaintiffs ought to have told defendants this would be so. Plaintiffs' reply was that they understood the dynamos would have nothing else to do but to drive the lamps. The defendants had paid £5 into court, and his Honour ultimately gave judgment for £1. 7s. 6d. more.

Transformers.—The Consolidated Telephone Construction and Manufacturing Company, Limited, have devoted a portion of their extensive new works at Coventry to the construction of alternate-current transformers, and also main switchboards. Some new features are to be introduced to make the machine one of the most economical in the market, and the works manager is Mr. S. Sudworth, who was long associated with Mr. Gisbert Kapp. The company's manufacture will be distinguished by the registered trade mark and the words "C.T C. and Manufacturing Company." There is every possibility of the company having to build on the piece of freehold ground belonging to them, their present workshops being fully engaged.

Llanelly.—At a meeting of the Property Committee of the Borough Council an estimate was submitted by Mr. J. C. Howell for electrically lighting the principal streets of the town. The Surveyor said he had gone into the proposal with Mr. Howell, and the latter stated he would light up the additional streets suggested by the Council and include them in his scheme. The surveyor calculated that the saving to the town would be £400 or £500 per annum. The question was deferred. At a meeting of the Town Council a letter was read from the National Telephone Company, quoting £9 per annum on a five years' agreement for telephonic communication between the town hall and company's exchange. The terms were accepted.

Continental Metropolitan Tramways.—A provisional agreement has been entered into between the Continental Metropolitan Tramways Company, Limited, and the Compagnie Française pour l'Exploitation des Procédés Thomson-Houston for the sale of the interest held by the former company in the Compagnie Générale Parisienne de Tramways, and also of the freehold property belonging to the company in Paris, for the sum of £392,800, together with the net profits of the company to June 30, 1896. The Board recommends, as a fair and equitable approximate scheme of distribution, to pay to the preference shareholders £5. 10s. for every £5 share, to the preferred ordinary shareholders £5 per share, to the ordinary shareholders £3 per share.

Coventry—At the Coventry County Court, before his Honour Judge Ingham, a petition for the winding-up of the Coventry Electrical Engineering Company, presented by Messrs. B. Verity and Sons, Birmingham, was called on. Mr. Masser, who appeared for the petitioning creditors, said he had received a notice from Mr. F. Thomas Jackson, a creditor, that he should oppose the order. Mr. Wilks represented Mr. S. T. Peirson, the liquidator of the company. He (Mr. Masser) had seen both Mr. Wilks and Mr. Maddocks (Mr. Jackson's solicitor), and an arrangement had been made that the matter should be adjourned till next court day. There was a receiver appointed for the debenture-holders and a voluntary liquidator, so that the estate would not be affected. His Honour granted the application.

Bristol.—The Electrical Committee having received applications from Mr. Harold Faraday Proctor, the electrical engineer, and Mr. John Rutherford Blaikie, the chief assistant engineer, for an increase of their salaries, recommend the Council to increase Mr. Proctor's salary to £400 per annum, increasing by annual increments of £25 to £500 per annum, it being understood that he will not seek to determine his engagement for three years from the time of the increase being granted; Mr. Blaikie is recommended for an increase of salary to £175 per annum, increasing to £200 per annum at the expiration of one year, on similar terms; and Mr. Thomas Henry Gait, the book-keeper in the office of the secretary to the electricity department, is recommended an increase to £120 per annum, rising by annual increments of £9 to £156 per annum.

Shoreditch (London).—The Vestry have amicably settled the dispute with the County of London and Brush Electric Lighting Company as to the rights of both parties in laying mains in certain streets originally bordering on the parish and now in the parish of St. Luke which is covered by the company's order. Messrs. Manlove, Alliott, and Co. have obtained a design from Messrs. Babcock, Wilcox, and Co. for special apparatus for blowing dust from the tubes of the boilers, involving an extra cost of £22 net on each of the six boilers The Vestry have, on the advice of the engineers, decided to purchase the apparatus. Forty-one applications have been received for the post of resident electrical engineer. The committee have selected six, and presented the name of one for appointment to the Vestry, but it was decided to instruct the committee to bring up the whole six to the Vestry.

Plymouth.—At the Borough Council meeting the Electric Lighting Committee recommended that with a view to prevent the necessity of reopening Old Town-street, Ebrington-street, and Ham-street after the street improvements now in progress were completed, application be made to the Local Government Board for authority to borrow the sum of £1,000, the cost of laying electric mains in those streets, and that the mains be laid prior to the completion of the street works. Mr. J. Willoughby, in moving the adoption of the recommendation, explained that the scheme of electric lighting had not been fully prepared yet, but in the judgment of the committee it was desirable to proceed with the laying of the mains in the streets mentioned, in order to avoid pulling up the thoroughfares again after the present improvements were completed. Mr. Jinkin seconded the proposition, which was carried.

Colchester.—The Electric Light Works Committee reported that schemes and tenders for establishing an installation for lighting certain portions of the borough by electricity had been received from the Brush Electrical Engineering Company, Limited, London; Messrs. Christy Bros., Chelmsford; the Electric Construction Company, Wolverhampton; and Messrs. Siemens Bros. and Co, Limited, Charlton. Messrs. John Fowler and Co. (Leeds), Limited, had written that as they were so busy they could not tender for execution of the works in reasonable time; and Messrs. Parsons and Co. had not sent in a tender. The tenders and conditions are given elsewhere in our columns. It was decided to accept the tender and scheme of the Electrical Construction Company, and to apply to the Local Government Board for sanction to the borrowing of £15,000 for the purposes of electric lighting.

Burnley.—The Town Council have approved of the appointment of Mr. W. R. Wright, of Manchester, as electrical engineer of the borough in place of Mr. Thursfield, resigned, at the salary of £200 per annum, to be increased to £250 per annum at the end of 12 months, providing his duties are carried out to the satisfaction of the Corporation. At the last meeting of the Council, Councillor Mercer (chairman of the Gas and Electric Lighting Committee)

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moved that the Council authorise the committee to lay electric cables along Church-street and Ormerod-road of a sufficient capacity to supply 2,000 lights, at an estimated cost of £1,000. There were promises for 12 consumers, representing about 460 lamps. The income from those promises was estimated as follows: the gas bills at present were £180 per annum, the interest and sinking fund on the new main would be £60, cost of supplying the current £72, and they estimated a profit by the transaction of £48. The motion was carried.

London.—At the Court of Common Council, Mr. Brooke Hitching asked the chairman of the City Commission of Sewers whether, in view of the high charges made by the City of London Electric Lighting Company for the electric light in the City—viz, 8d. per Board of Trade unit as against 6d. and 5d. in other parts of London—the Commission had reserved to itself the right to purchase the undertaking from the company on equitable terms, or, if not, what notice would be required to be given to the company in the event of the Commission desiring to acquire the supply. Mr. B. Turner, the chairman, replied that the Commission had power to acquire the undertaking compulsorily at the end of 21 years on terms specified by the Act, so far as the public lighting was concerned. As regarded private lighting, the Commission could at the same period agree with the company for the acquisition of their powers, and failing an agreement, there were provisions for arbitration.

Lincoln.—At a meeting of the Special Electric Lighting Committee, letters from the Board of Trade were considered, and it was resolved "that application be made to the Board of Trade for a provisional order enabling the Corporation to put in force the provisions of the Electric Lighting Acts, 1882 and 1888." The committee recommended that advertisements be issued for applications for the appointment of electrical engineer, at a salary of £300 per annum. The committee had further resolved "that a provisional contract be entered into with Mr. C A. Harrison for the purchase of 1,750 square yards of land on Brayford side, at the price of 17s. per square yard, in order to provide for the generating station of the proposed electric lighting works." The committee further explained that Mr. Harrison had provisionally agreed to take £1 500 for the 1,750 square yards of land (about 17s. 1½d. per square yard) and the vendors' costs to be paid by the Corporation. The minutes have been confirmed by the Council.

London Tramways.—At Tuesday's meeting of the London County Council consideration was resumed of the report of the Highways Committee recommending that the County of London Tramways Syndicate should be informed that the Council, having given full consideration to the proposals of the syndicate as to arrangements being entered into between the Council and the syndicate for the immediate transfer to the Council of all the tramways in the county of London, were not prepared to enter into any such arrangements. The Hon. E Hubbard M.P., thought there was considerable feeling outside the Council with regard to the scheme, and it was well that it should be considered in all its bearings. He therefore moved as an amendment, "That the further consideration of the committee's recommendation be adjourned, and that the Finance Committee be instructed in the meantime to consider and report on the financial bearings of the syndicate's proposals." Mr. T. W. Williams seconded, and the amendment was carried by a majority of 19.

Yarmouth.—The Electric Lighting Committee have reported that additional applications had been received for 152 lamps, bringing up the total number of lamps to 8,143. The income last month was £133. 2s. 2d., and the expenditure £128. 17s. 8d., £4. 4s. 6d. being earned beyond cost of production, while repayment of capital, interest, rates and insurances amounted to £100 per month. On this report coming before the Town Council Alderman Wiltshire said one would have thought that the larger the number of consumers the larger would be the profits, but from the report it appeared that it was in an inverse ratio. The ordinary outlay for carrying on the work nearly balanced the income, while the ratepayers were left to pay £100 a month, or £1,200 a year, for the privilege of those persons who had the electric light. Alderman Martins replied that naturally in May, when the days were longest, the profits were materially reduced as compared with the winter months, and it was quite untrue that a loss of £1,200 a year was being incurred. At this time of the year business establishments used the light very little, but the applications from private houses were more numerous each month.

Electrical Copper Company, Limited.—This is a new company registered by Tatham and Lousada, 17, Old Broad-street, E.C., with a capital of £500,000, divided into 500,000 shares of £1 each, in order to carry into effect an agreement bearing date April 8, 1896, and made between Emilien Dumoulin and R. M. Moir and Co., on behalf of the Company, for the purchase of patents relating to industrial electrolysis of metals; to acquire any other patents for inventions capable of being used in the manufacture or treatment of copper or other metals; and to develop them in such manner as the Company shall see fit. The signatories are: H. M. Matheson, 3, Lombard street, E C.; C. A Fould, 35, Avenue Monceau, Paris; E. Dumoulin, 19 Rue Miromesnill, Paris; A. McKechnie, Ditton-road, Widnes; R M. Moir, 1, St Swithin's-lane, E.C; R. Lorimer, 1, St. Swithin's-lane, E.C; L S. Johnson, 197, Dalston lane; and the first directors are H. M. Matheson, A. Fould, W Jacks, Alex. McKechnie, Robert M. Moir, and E. Dumoulin, with a qualification of 400 shares and remuneration £2,000 per annum and a percentage of the profits, divisible. The registered office is 1, St. Swithin's-lane, E.C.

Malaga Electricity Company, Limited.—This Company has been registered by Ashurst, Morris, Crisp, and Co., 17, Throgmorton-avenue, E.C, with a capital of £57,000 divided into 10,000 ordinary shares of £5 each and 7,000 deferred shares of £1 each, in order to adopt and carry into effect an agreement expressed to be made between Zulueta and Co. and the Company, and to carry on the businesses of electricians, producers, and suppliers of electricity for light, heat, power, or otherwise; as manufacturers of and dealers in every description of electrical apparatus, and as electrical and general engineers, ironfounders, etc., at Malaga, Spain, or elsewhere. The signatories are: J. M. de Zulueta, 41, Moorgate-street, E C.; R. C. Wyatt, 41, Moorgate street, E.C.; A. Hill, 5, Tokenhouse-yard, E C.; F. S. Isaac, 22, Great Winchester-street, E.C.; A. Fowler, 6, Lombard-street, E.C.; L. Floersheim, 4, Bank-buildings, E.C; T. W. Bernard, Malaga, Spain; and the first directors—of whom there shall be not less than three nor more than four—are R C. Wyatt, G. von Chauvin, and A. Fowler with a qualification of 50 shares, and a remuneration 5 per cent. of the net profits, divisible, with a minimum £400 and maximum of £800 per annum.

Bury St. Edmunds.—The report of the Electric Lighting Committee, the substance of which has already been given in these columns, has come before the Town Council. The committee unanimously recommended that Mr. Medhurst's scheme be adopted and that he be appointed consulting engineer at a fixed fee of £1,000, with an additional £100 for clerk of the works. Mr. Ashton asked if the town clerk (Mr. C. E. Salmon) had considered the question as to the position of members of the Council who were shareholders in the gas company. Could they take part in the discussion and vote? The Town Clerk saw no reason to modify an opinion he had previously given in favour of their doing so. Mr. Turner moved, and Mr. C. Oliver seconded, the adoption of the report. Mr Ashton urged that Mr. Turner had not gone into the financial aspect of the question. The figures which had been submitted were purely an assumption. No guarantee was given that the suggested 2,500 lights would be taken. He disapproved of engaging a consulting engineer at such an exorbitant retaining fee, and moved that a poll of the ratepayers be taken on the electric lighting question. Mr. Lacy Scott seconded this. After a good deal of discussion this amendment was lost by 12 to 10, but ultimately further consideration of the question of adopting the scheme was adjourned for a month.

Aberdeen.—At the meeting of the Town Council, the Streets and Roads Committees recommended the Council to intimate to the National Telephone Company—"(1) That from and after June 30, 1896, the company will be required (*a*) to pay to the Council a sum of 10s. per annum in respect of every telephone pole erected or to be hereafter erected in any street or public lane within the city, such payment to be subject to revision by the Town Council at any time on giving the company six months' previous notice; and (*b*) to grant the Council a reduction of 25 per cent. per annum upon the charge made by the company for all telephone connections belonging to the Town Council, such reduction to take effect from the several dates at which the respective charges are payable; and (2) that in other respects the conditions relating to the erection of telephone poles and wires are to remain as at present." The report was adopted. A letter from Mr. R. Gordon Nicol, harbour engineer, as to electric lighting at the quays, was remitted to the Gas and Electric Lighting and Watching and Lighting Committees. The communication suggested an arrangement whereby the Council would light the foot pavements at the docks and the Harbour Commissioners would light the quay sides. It was mentioned that about 80,000 Board of Trade units would be required. An offer from the National Telephone Company, Limited, to establish communication between Invercannie Reservoir and the city at a yearly cost of £15 has been refused by the Water Committee

Keswick.—The Urban District Council having at a special meeting offered to purchase the electric lighting company's works for £2,000, the company replied with a counter proposal that the Council should hand over the working of their provisional order to the company on the latter agreeing to lay down new plant and mains immediately, in accordance with the joint recommendations of the Council's and the company's engineers, at a cost of from £2,500 to £3,000, and to pay the expenses of applying to the Board of Trade for the provisional order, and from time to time make such additions as may be required to this plant in order to meet the extending requirements of the district, and generally to put and keep the undertaking in satisfactory order; also, the Council should give the company at once the lighting of their street lamps and all other lighting under their control at a price of 6d. per unit or such other contract sum as may be agreed upon. At the end of 5½ years the company agree to sell the undertaking as a going concern, the price to be paid being calculated as follows: (*a*) £2,000, the price now offered by the Council; (*b*) the amount expended by the company on the provisional order and in alterations and additions as considered necessary by the engineers on commencing to work the order; (*c*) the amount subsequently spent by the company in providing for the extending requirements of the district; (*d*) a sum for goodwill which shall be 10 years' purchase on the amount of profit being realised by the company at the time of taking over by the Council over and above an amount sufficient to pay 5½ per cent. per annum upon the capital arrived at by adding (*a*) and (*b*) together. After a great deal of acrimonious discussion the matter was adjourned for three weeks.

London Extensions.—The Highways Committee of the London County Council have reported having received notice under Electric Lighting Acts and Orders from the Vestry of St Pancras, who desire to lay pipes for telephone wires from the Fitzroy-road electric lighting sub-station along Fitzroy-road and Kingstown-street, and from the Cobden sub-station along High-street to a

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court adjoining. There appeared to the committee to be no objection to these pipes, which are for the Vestry's own use, being laid in the streets named. Also a notice from the St. James and Pall Mall Electric Light Company of intention to lay mains in Shaftesbury avenue subway, and in Wardour-street and Coventry street was reported unobjectionable A notice received from the House-to-House Electric Light Supply Company of intention to lay low-tension mains in Collingham-place, was recommended for the sanction of the Council, and also a notice of the same company to lay mains across Brompton road and to construct a transformer-box Other notices sanctioned were from the Charing Cross and Strand Electricity Supply Corporation to lay mains and construct street boxes in Oxford-street, Sutton street. Charing Cross-road, Cambridge-circus, Old Compton-street, Greek-street, Frith-street, Soho square and street, Dean-street, Carlisle-street, Little Chapel street, and to join the mains in Shaftesbury-avenue subway at three places; of the Kensington and Knightsbridge Electric Lighting Company of intention to lay mains in Burden-mews, Kensington; a notice given by the Westminster Electric Supply Corporation of intention to lay mains in Artillery-row and Howick-place; a notice from the Notting Hill Electric Lighting Company to lay mains across and along a part of Argyle road and along Stafford-terrace; a notice from the Metropolitan Electric Supply Company of intention to lay mains along the south side of St. John's Wood road (part) and the west side of Northwick-terrace; and, lastly, from the London Electric Supply Corporation of intention to lay mains in St. James's-place and Brook-street.

Bradford.—The work of the Corporation in the way of supplying electricity for lighting and other purposes has proved a success from the beginning, and an extension of the plant has become imperative. The present building could not contain all that was necessary, so it has been decided to erect another station. A site was purchased in Valley-road at a cost of £2 500, and on this a building is to be placed, the tenders for which amount to £11,588. The boilers, engines, dynamos, machinery, and plant to be fixed thereon will cost £17,593, thus bringing the total expenditure in connection with the new installation up to £31,368. The ceremony of laying the corner stones of the building has been performed, and the Mayor (Alderman W. W. Wood), in his remarks, claimed for the Corporation of Bradford the distinction of being the first municipal authority to set up an installation for electric lighting. It was seven years since the first station was opened, and they started with but three engines, three boilers, and 10 miles of cable. In the first year of the venture the financial statement showed a loss of only £1,250, which was decidedly encouraging. At the end of the second year it was £490, and during the third year they had a profit of £1,385 That was satisfactory, and he was pleased to say that from an estimate made it would appear that the profit during the year now closing would be something like £3,280. Their plant to day consisted of seven large boilers, 11 engines with over 2,100 h p., and 25 miles of cable. They had 402 customers, and their present supply covered an area of one square mile. When the new installation was completed, however, they would be able to cover nine square miles. It may be added that the works of the new station will be in one block, and will be divided into office buildings fronting Valley road, engine and dynamo room behind the offices, and a boiler-house running parallel with Lionel-street The ground floor will comprise the electrical engineer's office and general offices, opening out of a large tiled entrance-hall, with staircase leading up to the next floor. On the first floor will be a large committee-room, with windows overlooking the engine and dynamo room, and a storeroom and offices. The basement will be utilised for condensing plant The engine and dynamo room will be 85ft. long by 61ft wide and 28ft. high. It will provide accommodation for 12 engines and dynamos. It may be mentioned that the contractors have had to go some 10ft. below the surface of the ground to get a solid foundation. A travelling crane will run the whole length of the engine-house for moving any part of the plant. All the switches will be controllable from a platform which will run across one end of the engine-house. The plans for the building have been prepared by Mr. Thomas Barker, A.M.I.C.E., of Bradford, and the various contracts have been let as follows: masons' work, Messrs. J. Moulson and Sons, £7 350; joiner, Mr. Henry Thirkill, £810; ironwork, Messrs. Roberts and Co., £1,248; slaters, Messrs. Hill and Nelson, £267; plumber, Mr. R. Townend, £333; plasterer and concretor, Mr. Thomas Bolton, £414; painters' work, Mr. G. J. Walton, £116; wood-block flooring, Wood Block Flooring Company, £54; reservoir and tank, Messrs. J. Moulson and Sons, £890; gates and railings, Coalbrookdale Company, Limited, £123; and the condensing plant, Messrs. Cole, Marchent, and Morley.

Eccles.—At the Local Government Board enquiry, before Mr. G. W. Willcocks, into the application by the Town Council for power to borrow £20 000 for carrying out an electric lighting scheme and £11,348 for other works, Mr. G. W. Bailey, town clerk, represented the Corporation, and Mr. Overend Evans appeared for the Eccles Property Owners' Association, who opposed the electric lighting scheme; Alderman Spary opposed the grant of the order on behalf of a number of ratepayers; Mr. F. S. Hindshaw opposed on behalf of the Monton Green Ratepayers' Association; Mr. W. Broughton, a member of the Eccles Town Council, opposed as a deputation from a public meeting of the ratepayers; Mr. S. Hooley, Patricroft, for the Eccles Ratepayers' Association; and Mr. Alderman Mellor for the ratepayers of Patricoft. The Town Clerk, in support of the application for power to borrow £20,000 for electric light works, said the borough did not make its own gas, but obtained it from the Salford Corporation, and the charge at present was 2s. 4d. per 1,000ft. Therefore there was no question of setting up the works in opposition because of a dear supply of gas. Several companies, he said, had from time to time made application for powers to come into the borough and set up electric lighting works, and the local governing authority in order to prevent that had obtained provisional orders to carry out such works themselves. Some little time ago the Town Council, feeling that something ought to be done called in Dr. Hopkinson, who advised them that they could set up works and light the street lamps, etc, with electricity at practically the same rate as that paid to Salford for the supply of gas, and that, if that were done, within 25 years they would be able to redeem the cost of the works. A committee charged with the consideration of the scheme had ultimately adopted one designed by Mr. Clirehugh, which was on a different principle to that proposed by Dr. Hopkinson. This scheme was also opposed, and in order to find its cost tenders were asked for. The Manchester Edison Swan Company offered to carry out the whole of the works as regarded lighting for £13 792. Adding to that the tenders for buildings and other things the total was brought to £18,671, and that sum allowed 10 per cent. for contingencies. That showed that the work could be done for £200 less than Mr. Clirehugh's estimate. The scheme, he believed, was a moderate and reasonable one. Under it the Council proposed to light all the streets in the borough, and to adapt the present street lamps to incandescent electric lighting purposes. The Council also proposed to supply private consumers either for lighting or motive power. There would be a compulsory area, with separate wires, but the street-lighting throughout the borough would be all under one system. Mr. Alderman Kendall, chairman of the Electric Lighting Committee, gave evidence in favour of the scheme. Mr. Clirehugh, electrical engineer, in evidence, stated the works would have a capacity for lighting 750 public lamps of 20 c.p. and 3,750 private lamps of 16 c.p. A little over 21 miles of street cable would be laid. His estimate of the cost of the scheme was £18,971. The witness was cross-examined to show, amongst other matters, that his scheme differed entirely from that suggested for Eccles by Dr. Hopkinson. He said that Dr. Hopkinson's system was scarcely calculated to reach the smaller houses and there were many occupiers of small houses who now took the electric light. There were no accumulators in his scheme; he did not want them. Mr. Fawcus, of the Manchester Edison-Swan Company, gave evidence in support of the scheme, and the enquiry was adjourned.

Glasgow.—A discussion took place at the meeting of the Corporation as to the motor power to be used for the tramways. Treasurer Gray said that statements had appeared in regard to it, and he certainly expected that a report would have been laid on the table that day. He wanted to know if people might assume that the report which had already been submitted was complete, and that the committee had now travelled over the ground, and there would be a report at next meeting of Council, or, perhaps, in the middle of the month. Mr. Walter Paton stated that the matter was too important to be decided either in a week or a month even. It required very careful consideration in all its bearings. At present the Motor Committee were fully considering the matter, and he thought that within a reasonable time they would be able to give to the Council a report which he thought would be generally satisfactory. He did not think that there was any necessity for the committee to visit any other places to see anything more. Treasurer Gray gave notice to move at next meeting that, in view of the possible alteration of the tramway motors within the next few years, and after providing for all expenditure already incurred by the Town Council, the balance of the tramways surplus be applied first to a substantial reduction of the debt already incurred, and the balance be paid over by the Financial Committee to the Police Department in relief of the police rate. The Tramway Committee have received from the Simplex Electric Tramway Conduit Syndicate, Limited, drawings and estimates for the application of the conduit system of traction in Glasgow. According to the system, the conduit is formed under one of the track rails, a slot ⅜in wide giving access to the conduit, replacing the ordinary rail groove. A flexible conductor is supported at intervals of 30ft. on hook-shaped arms carried on insulators These insulators are placed in small chambers formed at the side of the conduit. The collectors consist of insulated conductors provided with U shaped contact-shoes carried in shanks, two collectors being attached to each car. The conductor is allowed to glide through these shoes, which pass over the supporting arms, the conductor being lifted during their passage and falling back again after the car has passed. The whole of the roadway can be constructed before any of the electrical appliances are placed in position, and when the line has been completed the insulators can be readily placed in the side hatchways by lifting the lids provided for that purpose. Assuming that the existing tramway is in good repair, the cost of the work is estimated at £3,000 per mile single line of track, or £6 000 per mile double line of track. In cases where the tramway rails are not in good repair the cost is estimated at £4,000 per mile of single line of tramway, or £8 000 per mile of double track. The company suggest, for demonstration, the Springburn route, and offer to carry out the whole work at their own expense. Should the installation give satisfaction, the Corporation will pay the cost of the work as per tender, but should the work not be satisfactory they will only pay for so much of the work and rolling-stock as they may be able to use for the purposes of an overhead installation, should they decide on its substitution for the conduit system. The reconstruction could be carried out without interruption of the existing traffic, and the permanent way provided would be

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suitable for the overhead system. The necessary power could be supplied from the existing electric light station, so that the existing plant might be utilised during the day, when there is but little demand for light, for the purpose of working the tramways.

PROVISIONAL PATENTS, 1896.

JUNE 1.

11858. Improvements in portable electrically-driven pumps. James Compton Merryweather, Greenwich-road, Greenwich, London.

11891. Improvements in automatic grip clutch for straining wires for telegraphic, telephonic, and like or similar purposes. William Phillipps 76, Chancery-lane, London.

11894. Improved means for opening and closing doors by electricity. Solomon Cambie, 76, Chancery-lane, London.

11903. An improved frictional electric machine. Heinrich Sobersky, 6, Lord-street, Liverpool.

JUNE 2.

11973. An improved movable platform for electric lamp-posts. Albert Dalolry, 1, Grove-place, Broadway, Ealing.

11981. Improvements in and connected with electrical indicating apparatus. James Grieve Lorrain, Norfolk House, Norfolk-street London. (Mathias Pfatischer. Edward S Hosmer, and Harold Binney, United States)

11985. Improvements in and connected with electric arc lamps. Charles Edward Harold Edman, 23, Coleman-street, London.

11999. In or relating to marine telegraphy. Richard Joseph Crowley, 58, Lincoln's-inn-fields, London.

12028. Improvements in and relating to caps for electric incandescent lamps. Reuben James Bott, 11, Southampton-buildings, Chancery lane. London.

12039 Improvements in transmitting electrical impulses and signals and in apparatus therefor. Guglielmo Marconi, 24, Southampton-buildings Chancery-lane, London.

JUNE 3.

12070. Improvements in transmission dynamometers. William Ernest Dalby, Engineering Laboratory, Cambridge University.

12149. Improvements in electrolytic apparatus. Trevenen James Holland, 6, Bream's-buildings, Chancery-lane, London.

JUNE 4

12178. Tamplin's new electric bicycle lamp. Archibald Hubert Tamplin, 29 St. George-street, Leicester.

12183. An improved method of electric traction by means of the conduit system. William Cope, 127, Bristol-road Birmingham. (Complete specification.)

12187. A new or improved shade and reflector for electrical and other lighting. George William Pridmore, Thomas John Sturgeon, and Edwin Yorke, 2 Broad-street buildings, London.

12227. An improvement in secondary voltaic batteries. Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London

12244. New or improved electrical lighting apparatus. Ernest Oldenbourg, 115, Cannon-street, London.

12248. Improvements in or connected with automatic switches for controlling electric lamps. William James Davy, 40, Chancery-lane, London.

12249. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

12250 Improved plates for secondary galvanic batteries and a method of producing the same. Carl Marschner, 45, Southampton-buildings, Chancery-lane, London

12259. Improvements in or connected with dynamo-electric machines. Valerè Alfred Fynn, 47, Lincoln's inn fields, London.

12266. Improvements in electricity meters. William Morris Mordey, 46, Lincoln's-inn-fields, London.

JUNE 5.

12275. Self-lighting and part driving of vehicles by electricity. Michael Twomey, 42, Pope's-quay, Cork. (Michael Twomey, ———.)

12312. A new or improved apparatus for electrically smelting metals and for other purposes. John Laskey Dobell, 57, Chancery-lane, London.

12329. Improvements in electrical switches. Gustav Binswanger, 73 St. Stephen's-road, Upton Park, London

12330. Improvements in electrical switches. George Wilkinson, 73, St. Stephen's-road, Upton Park, London.

12344. Method of indicating at a telephone station whether the telephone lines are engaged or not. Emil Naglo, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12345. Automatic apparatus for the working of telephone stations. Emil Naglo, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12360. Improvements in or connected with variable gearing applicable to wheeled vehicles driven by electricity, petroleum, steam, or other motive power. Frank Frederick Wellington and Edwin Percival Allam, 33, Chancery-lane, London.

12362. Improvements in and applicable to electrical accumulators. Joseph Tabrar, 57, Crampton-street, Newington Butts, London.

JUNE 6.

12398. A flexible crystal covering for electrical conductors. Lewis Davis 36, Spital-square, Norton Folgate, London.

SPECIFICATIONS PUBLISHED.

1892.

2329*. Bleaching by electrolysis. Imray. (Montgomery.) (Amended specification)

1895.

9372. Electric oven Middleton and Neale.

9433 Electrically signalling on locomotives. Burn and Tate.

9882. Electric conduits Safety Tread Syndicate, Limited, and others.

10155. Telephone systems Freudenberg.

11085. Arc lamps Andrews.

11951 Telephonic exchange system Berditschewsky (called Apostoloff)

12417. Secondary battery plates. Weise

12690. Electrically-propelled vehicles. Brault and Jeantaud.

13619. Electric railways and tramways. Wetter. (Elektrizitats Aktien Gesellschaft vorm. Schuckert and Co)

23250. Electric accumulators. Schneider.

1896.

2501 Conveying electricity to railway cars. Krotz and others.

3627 Telephones. Russell and others

5171 Arc lamps, electroliers, etc. Baker.

5951 Electric cars. Devonshire. (Bassett.)

6576. Microphones. Hardegen.

7794. Incandescent electric lamp shade holders. Hellyer.

7881. Electric current transformers Devonshire. (Moody).

7884. Electric current power systems Devonshire. (Berg.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1½ 1⅝
—— Non. Cum., 6 per cent. Pref.	2	1⅝-1¾
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	8½ 8¾
Chelsea Electricity Company	5	7⅞-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	4½-15½
—— 6 per cent. Cumulative Pref.	10	16½-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	14½ 15½
County of London and Brush Provincial Co., Ordinary	10	8½-9½
—— 6 per cent. Cum. Pref.	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1½-1⅝
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	1⅞ 1⅞
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	1-1⅛
Elmore's Wire Company	2	1⅛ 1⅛
W. T. Henley's Telegraph Works, Ordinary	10	16-17
—— 7 per cent. Preference	10	17-18
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	3⅜-3½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	105-107
Isle of Man Electric Trams, Ordinary	1	1⅛-1¼
—— 6 per cent. Preference	1	1⅛-1¼
Kensington and Knightsbridge Ordinary	5	9-9½
—— 6 per cent. Pref.	5	7½-8
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	17½-17⅞
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	1-1½
Metropolitan Electric Supply	10	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7⅜ 7½
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜ 6½
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	9-9½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8⅞
—— £4½ shares	4½	7½-7⅞
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4⅜ 5½
St. James's and Pall Mall, Ordinary	5	10½-11½
—— 7 per cent. Pref.	5	10 11
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	6	8-8½
Westminster Electric Supply, Ordinary	5	9½-10
Yorkshire House-to-House	5	7½-8

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NOTES.

Institution of Electrical Engineers.—We may remind our readers that the annual conversazione of the Institution takes place on the 25th inst. at the Institution of Painters in Watercolours.

Hartlepool Tramways.—In consequence of extreme pressure on our space, we are compelled to hold over the description of the Hartlepool tramways which we hoped to have given in this week's issue.

Book Received.—We have to acknowledge the receipt from Oskar Leiner, of Leipzig, of Mr. Arthur Wilke's book on the mutual influence of telephones, which we hope to notice at greater length shortly.

New Anglo-German Cable.—The German Reichstag has passed the second reading of the supplementary credit of 1,288,000 marks for laying a fourth telegraph cable between Germany and England.

Foyers Aluminium Works.—Last week the water of the river was diverted into the tunnel of the British Aluminium Company at Foyers. It will be remembered that the whole of the works were described in our columns a short time ago.

Personal. — Mr. A. P. Lundberg, who has been dangerously ill from erysipelas, the result of a bicycle accident in April last, is now out of all danger, and it is hoped that in a month's time he will be quite convalescent and able to resume business.

Motorcart Competition.—It is announced that the Brussels paper *L'Industrie* proposes to have a motorcart competition somewhat after the fashion, though on different lines, to that of the *Engineer*. Details and conditions are promised to be given shortly.

Physical Society.—The following are the papers to be read at the Physical Society on June 26: (1) "Admittance and Impedance," by F. Bedell; (2) "On the Properties of a Body of Negative Resistance," by S. P. Thompson; (3) "On Bare Wire Resistances," by H. F. Burstall.

Electrolysis.—Mr. D. Tommasi has proposod a new arrangement of plates for electrolytic purposes, and communicated his proposal to the Paris Académie des Sciences. The essential part of the arrangement is to have two anodes, and one cathode between them. This is circular in form and only dips about halfway into the solution. It is mounted on a shaft and revolves slowly between rubbers.

Telegraphs in Borneo.—It is stated that the land line across British North Borneo, which has been in course of construction for some time past, is expected to be completed by the middle of September. The two opposite working parties hope to meet this month. The construction of the line to Sandakan will place the capital of British North Borneo in direct telegraphic communication with England *viâ* Labuan and Singapore.

Rural Telegraphs.—In the course of his reply to a deputation which waited upon him last week on the subject of telegraphic communications, Mr. Walpole made the interesting statement that on the average not a week passed in which the Post Office did not open five new offices in different parts of the country. It is also to be arranged that telegrams in rural districts should be delivered by cycle instead of by man and horse. The effect of this is that the charge will be 4d. instead of 1s.—which is good. It is, however, to be hoped that a certain amount of discretion will be allowed as to sending out telegrams by bicycle over muddy cross-country roads in the winter time.

Telegraphs in Siam.—It is considered probable by *Indian Engineering* that when Mongsin comes under French administration more will be heard of the project to link up the Indo-Burma telegraph system with the Tonkin wires. At present Kengtung is the terminus of the telegraph from Burma. The French wire stretches from Hanoi up the Red River to Mong Low Kai, and thence turns in eastward to Mong Lai. In the Mekong Valley the French have also run the telegraph to Keng-Kan, and have possibly extended it to Luang Prabang. The best route for the connected line to take would be from Kengtung to Mong Lai, about 230 miles.

Cambridge to Glasgow.—It is part of the duty of the Cambridge Public Orator to put into classically beautiful Latin things that the Latins never dreamed of, much more named, and when he has to write a complimentary address to a modern man of science he has some work to do it. But our own schoolboy, to whom, as having had less time to forget, we refer such matters, absolutely refuses to translate "septentrionum regionem accuratius indicasti" in Dr. Sandys's address to Lord Kelvin on the occasion of his jubilee by "invented an improved form of mariner's compass." Yet, if it does not mean that, what in the world does it refer to?

Illuminated Rifles.—The tales of tiger hunting by electric light, the invention of which is a kind of agreeable exercise for the overworked brain of the Anglo-Indian, appear to be accepted quite seriously by *L'Etincelle Electrique*, and, what is worse, that journal says the "Prussian" army want to play the same trick on the enemy that the Anglo-Indian does on the tiger, and have actually gone so far as to fix small electric lamps—why not the ordinary bullseye lanterns?—on their rifles. Our contemporary anticipates that these will not prove of much use against men armed with Lebel rifles having a range two-thirds of a mile.

The Motorcart Bill.—The Bill for the legalisation of motorcarts has passed the House of Lords. It has, of course, still to go through the more serious ordeal of the Commons, and considering the position of business in the Lower House it is to be hoped that there will be no very serious opposition to it there. For although the motor carriage may not be going to do just at present all that some of its advocates expect, so many arrangements have been made in view of the early removal of the existing legislative restrictions that even a delay of a few months in the passing of the Bill would cause great disappointment, inconvenience, and loss.

Lightning.—It is a popular notion (though, of course, there is no real warrant for it) that lightning never strikes twice in the same place. The *Pall Mall Gazette*, however, reports that last Sunday during a severe thunderstorm at Glasslough, a village in Ireland, the tower of the parish church was struck by lightning, and a heavy stone pinnacle fell to the ground. A few moments afterwards a second flash entered the building, where evening service was being held, and several worshippers sustained slight shocks and burns. It is added that "the panic among the congregation was so great that the service was suspended." We should think it was. They may call that sort of thing panic in Ireland, but hereabouts it would be considered justifiable precaution, pending the conclusion of the storm and the examination of what was wrong with the lightning conductor.

An Australian Difficulty.—It is in the ordinary course for the consulting engineer to consider whether he

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can or cannot get condensing water for his engines; but what would he do if he could not get water for his boilers at all? Mr. G. E. Addenbrooke's answer to this conundrum is, "Use oil-engines." At any rate, that is what he recommended to the Westralian Electric Light and Supply Company, Limited, which has carried out the electric lighting of Coolgardie. Of course, in a place where there is any amount of gold and no water, one's ideas of economy require to be entirely reconsidered. However, the Westralian Company, having bored deep enough, have struck water in quantity which does not play the Australian joke of coming up hopelessly salt. So this interesting example of electric lighting under difficulties is to be superseded by a common steam plant.

Society of Arts.—The conversazione of the Society of Arts took place on Wednesday night at the South Kensington Museum. There were a very large number of guests, who were received by Major-General Sir John Donnelly, K.C.B., the chairman, supported by members of the council and the secretary, Sir Henry Trueman Wood. Amongst those present were Sir Douglas Galton, Sir Henry Roscoe, Mr. Preece, Sir Frederick Bramwell, Mr. Alexander Siemens, Sir Guildford Molesworth, Lord Belhaven and Stenton, Dr. and Mrs. Schofield, Prof. and Miss Hughes, Prof. Unwin, Dr. and Miss Routh, Mr. Webb, Sir John and Miss Fisher, and Captain Abney. There was a promenade concert in the north court by the band of the Royal Artillery and in the textile court by the Red band, and there was a vocal and instrumental concert in the lecture theatre.

Meteorological Society.—The last meeting of the Royal Meteorological Society for the present session took place on Wednesday, when Mr. H. Harries read a paper on "Arctic Hail and Thunderstorms," in which he showed that the accepted opinion that hail and thunderstorms are almost, if not quite, unknown in the Arctic regions is incorrect. He had examined 100 logs of vessels which had visited the Arctic regions, and found that out of that number no fewer than two-thirds showed that hail was experienced at some time or other. Thunderstorms were not so frequent as hail, but they have been observed in seven months out of the twelve, the month of greatest frequency being August. Mr. Harries thinks the breeding place of thunderstorms in these high latitudes is in the neighbourhood of Barents Sea. A paper by Mr. J. E. Cullum on the "Climatology of Valentia Island" was also read.

Night Signals at Sea.—Some experiments have been carried out at Portsmouth with a new night-signalling apparatus, the invention of a Captain Sellner, an officer in the Austrian navy. The signalling is carried out with two lanterns, on either of which five different arrangements of red and white lights can be shown, the two together being able to show no less than 30 different combinations. Electric lights are used for the lanterns, and though separate batteries are used for the lights and for the signalling apparatus by which the lights are changed and obscured at will, eventually it is intended that one dynamo shall be so arranged as to supply all the current required. A check on signals sent by the apparatus is obtained by a device by which the message sent is automatically printed by the working of the signals. It was found that no difficulty was experienced in reading the signals at a distance of six miles and more.

Flying Machines.—It will be remembered that Prof. Langley in the United States recently made a flying machine which, contrary to the custom of flying machines, really flew. The trials were made as privately as is possible for such a thing to be done, and very little was known about the machine or the motor used. Mr. H. S. Maxim now writes to the *Times* to say that Prof. Langley has been working on the same lines as himself. "In regard to the future of flying machines, I would say that if machines are to be made on the aeroplane system small ones will be found to work much better than large ones. Should Prof. Langley increase the size of his machine sufficiently to be enabled to carry one man he will find that the building material, which is steel and aluminium, is not relatively so strong for a large machine as for a small one, and a large machine in order to lift has to be propelled at a much higher speed than a small one." That is so. The biggest birds cannot fly, and, if the geological record is to be depended on, never could.

Metropolitan Railway. — Experimental trains having been run on the Metropolitan Railway at the only time when they could be run without disturbing the traffic—namely, late at night—someone jumped to the conclusion that the company was about to adopt electric traction. Several paragraphs on the subject having appeared in London and provincial papers Mr. A. B. Garside, the assistant manager of the company, was interviewed on the subject and at once contradicted the statement. Mr. Garside said that his company, in conjunction with others, had long been studying the matter of electric locomotion, but the experiments that had taken place were not in connection with that matter, but simply to ascertain the effects of curves and gradients on certain portions of the line. Even if the author of the report had no idea of what would be necessary before a trial of electric traction could be made, it is curious that it should not have occurred to him that an electric train would hardly be pulled by a steam locomotive.

City and South London Railway Bill.—Outside the ordinary and natural difficulties of construction and compensation to interests affected by it, the City and South London Railway seems to have more than its fair share of obstacles to overcome. The preserving intact all the empty and unused City churches at one time threatened to seriously endanger the Bill for the extension to Finsbury-pavement and Islington. This difficulty was got over before the Bill left committee, but no sooner did it come before the House than there was a motion to recommit it in order to use it as a pretext for fighting the question of whether the law should not be altered to allow a vestry to levy rates on unoccupied property. It may be good parliamentary tactics, but it hardly seems a straightforward course to attempt to get an important and far reaching precedent established by working it in under the form of an amendment to a private Bill, and it is certainly unfair to the enterprise affected. In this case, however, the House of Commons promptly stopped the attempt by a majority of 122.

High-Voltage Power Transmission.—The Westinghouse Company, in connection with the Telluride Power Transmission Company, of which Mr. L. L. Nunn is general manager, is carrying on some experiments in power transmission at high voltage at Telluride, in the United States. According to the New York *Electrical Engineer*, Mr. Nunn has been supplied with converters amounting in all to about 200 h.p. capacity, and suitable for transforming from 3,000 to any desired higher voltage up to 60,000 volts, and these converters are used as raising and lowering transformers in transmitting about 100 h.p. over an ordinary iron telephone wire a distance of about two and a half miles to operate a stamp mill, the iron wire constituting the line costing only 35dol. (£7). When Mr. Nunn first proposed this transmission of two and a half miles

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some years ago, using direct-current transmission, the estimate made for copper was in the neighbourhood of 65,000dol. (£13,000). This transmission plant has been run at various voltages, from 15,000 to 60,000 volts inclusive, and during snowy weather at about 35,000 volts.

Electric Waves.—Some experiments made by Cole's method on the refractive index and reflective power of water and alcohol for electric waves have been described in the *Annalen der Physik und Chemie*, from which it would appear that for waves of 300cm. to 600cm. length the refractive index for water was 8·95 and for alcohol 5·20, which is in agreement with the figures obtained by other observers. With waves of 5cm. length the two Fresnel formulæ give the same value of the refractive index from the observed reflective power; for water it was 8·8 and for alcohol 3·2; for alcohol the refractive index for long waves is appreciably greater than for short ones. It also appears that waves 5cm. long pass only with great difficulty through even very thin layers of water of 0·04cm., although long electric waves readily pass through the water and both traverse with ease wood, paper, rubber, and many other opaque materials. With these waves reflection is total from metals when the oscillations are at right angles to the plane of incidence and only partial when they are parallel to this plane. It will be seen that all these values are exceedingly high compared with those for the longest known light waves.

Acetylene.—At the convention of the National Electric Light Association in New York a paper was read by Mr. Ferguson on "The Commercial Value of Acetylene Gas," which makes out anything but a glowing prospect for that illuminant. The manufacture of calcium carbide at generating stations as a means of keeping the machinery employed during periods of light load it would not pay commercially, and would be bad policy from a business point of view. Acetylene manufactured from carbide does not give so much light by 28 per cent. as is obtained by the direct use in incandescent lamps of the electric energy necessary to produce the carbide, while comparison with the electric arc is out of the question. The final conclusion is that, "in the light of our present knowledge, and upon the basis of the estimated cost of production of the calcium carbide, acetylene gas should not drive the incandescent and arc lamp from the lighting field, neither should it make such inroads on the electric lighting business as to materially affect the earnings of existing central-station companies, for, after all, acetylene is a gas and burns with a naked flame, and the use of incandescent and arc lamps has steadily increased year by year, not because of their cheapness, but because of their infinite superiority as illuminants over any gas flame yet developed."

The Metric System.—At the Congress of Chambers of Commerce of the Empire last Saturday the final resolution on the paper related to the metric system. Mr. J. X. Perrault (of Montreal) moved: "Whereas the British system of weights and measures, which vary constantly in every part of the British Empire, is a source of constant annoyance, loss of time, and a formidable obstacle to local, Imperial, and foreign trade; and whereas the metric system has now been universally recognised as the most perfect decimal system, and generally adopted by nations of both continents, with the exception of the British Empire and the United States of America; be it resolved, that the metric system of weights and measures be adopted without further delay by the several Governments of the Empire, the yard being extended to the metre, the quart to the litre, and the two pounds weight to the kilogramme." This was seconded by Colonel Harding (Leeds), and, after discussion, was agreed to, but a further resolution dealing with a decimal currency was adjourned till the next congress. It is easier for a congress to pass a resolution than to get it adopted, however mandatory may be the terms used. But seriously, if and when the "several Governments of the Empire" comply with the commands of the Congress of Chambers of Commerce, would it not be better to do the whole thing at one stroke? The confusion and trouble of the change will be bad enough without arranging that as soon as we have adjusted our prices to the new weights and measures, we shall have to go through the whole process again in order to fit the prices to the new money.

Ayrton's Magnetic Tester. — At the Central Technical College conversazione last Friday an interesting exhibit, which was practically absolutely new to most of the visitors, was Prof. Ayrton and Mr. Mather's apparatus for testing the magnetic properties of iron. As with the exception of the Royal Society's soirée two nights before this has never before been publicly shown, and has only been very briefly described by its authors, rather more space may be given to it than can be afforded in our account of the conversazione. The instrument at first sight looks like a very small dynamo with abnormally developed pole-pieces and an exceedingly small air-gap, and as such might be easily passed by as a mere model without its practical purpose being guessed at. On closer examination the above description is seen to be substantially correct, with the exception that there is no core inside the coil of the field magnet. The sample to be tested is inserted here and completes the magnetic circuit through the pole-pieces and armature. This latter is run at a constant speed (something over 1,100 revolutions per minute), and the number of the coils is so adjusted that 10 times the magnetising current, as measured by an ammeter in the exciting circuit, gives H, while the E.M.F. in the armature circuit, read by a high resistance or an electrostatic voltmeter, requires only to be multiplied by 10,000 to give the value of B in the sample tested. It will be seen, therefore, that by varying the exciting current a curve can be plotted straight away. The instrument has been in use for some time in the laboratories of the institute, and is looked upon there with much favour. Several hysteresis curves plotted by its means were shown, and in one (of what appeared a rather bad sample of iron) the corrected values were also plotted in red. For a large portion of the lozenge curve the two traces were practically superposed, and at no point was there more than a very slight distance between them.

Institution of Naval Architects.—Last week the Institution of Naval Architects, after meeting at Hamburg, adjourned, by invitation of the German Emperor, to Berlin. On the first day the Emperor was present at the discussion, and throughout great attention appears to have been shown to the members of the institution. Mr. Dietrich, Constructor-in-Chief of the Imperial German Navy, in the course of a paper on the development in design and construction of German men-of-war, said the German vessels carried every athwartship bulkhead above the water-line without any door in it, while communication from one engine-room to the other was established only over the protective deck above water, or might be carried on below by telegraphs and speaking-tubes. In this England might with advantage copy Germany, and, again, in employing electricity as much as possible instead of steam. The German Admiralty found that the only way to get rid of the heat from numerous steam-pipes was to do away with them. By the use of electricity the conducting wire took the place of the steam-pipe, and the ships were rendered more healthy as well as safer in action. All

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new German warships have electricity as the motive power for ventilating fans, turning gear of gun turrets, ammunition hoists, coaling winches, and such purposes. Some discussion followed on the subject. At a subsequent meeting there was a further discussion on the watertight-door question, which at one time threatened to become heated. It is probably necessary to have lived some time on a man-of-war to be able to enter into the feelings of some members on the subject. When several of them had liberated their minds on the subject, a paper by Mr. Eichenradt on the use of electricity on board ships was taken. The members, of course, visited the Berlin Exhibition and several works. There were complimentary dinners and luncheons, and the Emperor held a special reception in honour of the institution.

Dyemaking. — The Chicago *Electrical Journal* says "that some of the colouring matters hitherto only produced by strictly chemical processes can also be manufactured by electrolytic processes, and it seems extremely likely that the near future will see a very large number of such substances being made by electro-chemical means. Towards the end of last year it was discovered that certain orange colouring matters can be obtained by electricity, and now we understand that they are being made on a commercial scale at Basle, in Switzerland. It seems that by reducing the yellow alkaline condensation products of p-nitroluene sulphonic acid in an alkaline solution by means of the electric current, the yellow colouring matters are converted into orange dyestuffs. A mercury cathode is preferably employed, as the production then proceeds at a lower temperature. The best strength of current is 5-15 amperes per square decimetre of cathode area. About 10 kilos of p-nitroluene sodium sulphonate are condensed in the usual manner in an aqueous solution with 30 kilos of soda lye of 30deg. B. After dilution with 70 litres of water, the whole is reduced at 45deg. C. in an electrolytic cell with a mercury cathode until a sample is spotted on paper which shows a red spot free from yellow. The solution is then neutralised and the dye-stuff salted out. After filtering and drying, it forms a dark-brown powder easily soluble in water, with a yellowish-red colour, and in concentrated sulphuric acid with a dark violet-blue colour. It dyes unmordanted cotton orange from a neutral or alkaline bath, fast to air, chlorine and acids. If this new process stands the test of time, and succeeds in producing dyes which possess as good qualities as the same substances manufactured by chemical processes, and at the same time possess commercial advantages, we may anticipate that a new and important field will be opened up."

An Irrigation Plant.—The *Journal Officiel* of the Egyptian Government gives some particulars of the opening by the Khedive, on May 18, of an electric installation at Korachieh which presents some points of interest. A difficulty in the way of all agricultural machinery is that a large plant must be provided capable of dealing with the crop when it is ready and which, after getting through its work, has to stand idle for the greater part of the year. Unless, therefore, it can be turned to some other purpose, the capital expense becomes exceedingly heavy in proportion to the work done. The Commission of the Egyptian Domain had at Korachieh, near Tantah, a cotton-cleaning plant run by a steam-engine of 120 h.p. This works only from the middle of September to the end of December, and stands idle for nearly three-quarters of the year. To one of the engineers of the Commission, Mr. Souter, was due the idea of utilising this engine for the purpose of providing the power necessary for pumping the water for irrigating 5,200 feddans (about 5,726 acres) of agricultural land. This has been successfully carried out, and the nine 12-h.p. engines and pumps formerly in use for irrigation purposes have now been replaced by three pumps driven by motors with energy derived from the cotton works engine. The generator is a four-pole continuous-current dynamo separately excited, and each of the pumps is driven by a two-pole motor. The makers are Messrs. Hillairet-Huguet, of Paris. The distances of the pumps from the cotton works are about $2\frac{3}{4}$ miles, five miles, and two miles respectively. The following was the cost of the electrical part of the work, the figures being in Egyptian pounds, which, however, only differ by a penny or two from sterling money. For 33,500 metres of copper wire, insulators, switches, poles, and the ordinary accessories, £E1,030; dynamos and motors, £E1,025; pumps, belts, etc., £E770; buildings, £E750. This, with the addition of a telephone and items for Custom House charges and cost of erection, brings the total up to £E4,280. It is estimated that as a result of this expenditure there will be an annual saving in coal, wages, etc., of about £E660, but the portable engines used for driving the pumps were old ones and might have been replaced by engines of a newer type, in which case the annual saving would have been £E390 in favour of the electric working. No further details beyond those given above are available as to the character of the transmission line, and the voltage is nowhere stated.

Electric Locomotives.—The General Electric Company have shipped from the Schenectady works the last of the three great electric locomotives for the operation of all trains on the main line of the Baltimore and Ohio Railroad. These locomotives will handle the entire freight and passenger traffic of the Baltimore and Ohio road passing in and out of Baltimore from the North, through the Belt Line tunnel, which passes under the city. Each locomotive weighs 96 tons and is capable of developing 1,500 h.p. The first was put into service in August last and the second in December, since which date they have been handling the entire freight traffic of the Baltimore and Ohio road through the tunnel without accident of any kind. No limit of speed has yet been reached with these engines. Eighty miles an hour has been attained, at least an American contemporary says so, but short-distance records of this character are never looked upon in railway circles as very reliable, and from what follows it will be seen that it is quite probable that the speed is a computed and not a measured one. As soon as the third locomotive reaches Baltimore it will be put into work, and the three engines will then undertake the passenger service as well as the freight traffic, and the present coke-burning engines used with the passenger trains will be shut off before entering the tunnel. Particulars of the working of the tunnel with these locomotives were given some time back in the New York *Electrical Review*. From these it appears that the smallness of the leakage in the overhead construction has exceeded all expectations, considering the dampness in the tunnel. The working voltage is 630. It has been found that there is quite a knack in starting the train, and the present operators say they can start a train without jerks better than with the steam locomotive. The pull of the locomotive was measured with a dynamometer car, from which the draw-bar pull per ton of train on the 0·8 per cent. grade was calculated, and was found to be 22lb., which, after subtracting the grade pull of 16lb., left a difference of 6lb. as the train resistance per ton. The draw-bar pull per ampere was found to be 28·6lb. An electrician on the locomotive is not necessary, as the present locomotive engineers operate it very successfully. Acceleration was measured by taking two-second readings and

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plotting the curve; a train of 985 tons could be accelerated up to a speed of about 12 miles an hour in one minute; probably steam locomotives could not equal this. A speed of 61 miles an hour up grade has been reached, and this is considered to be equivalent to 70 or 80 miles on a level. With a 300 or 400 ton train a speed of 40 to 45 miles an hour can be made.

The Pacific Cable.—At the meeting of the Congress of Chambers of Commerce of the Empire last Friday the proposed Pacific cable was discussed. Mr. J. X. Perrault, of Montreal, moved that, "Whereas an extension of direct telegraphic communication throughout the Empire would considerably facilitate and increase the commercial relations of the mother country and her several colonies, and be also a source of security and strength in maintaining uninterrupted hourly communication in time of war, and whereas the Atlantic and Canadian systems now extending to the Pacific coast offer special advantages over all other routes to establish direct telegraphic communication between the mother country and Australia through uninterrupted British territory, be it resolved that, as an alternate and direct line of communication, a cable should be laid between Australia and Canada without further delay, the Imperial and Colonial Governments directly interested being respectfully requested to offer such inducements to the constructing company as may determine the laying of the Pacific cable at the earliest possible moment." The Hon. Robert Reid seconded the resolution, and Sir Mackenzie Bowell suggested that the words "to the constructing company" should be omitted. There were those who held that a cable of the character intended to be exclusively British should be constructed, owned, worked, and managed by the different Governments, and the reason for that proposition must be apparent to any one who would give the subject a moment's consideration. Although the cable might be laid by a company, those who invested their money in an enterprise of that kind must expect to receive some return for it, and if it was placed in the hands of promoters they must anticipate making a certain amount of money out of it. If, however, it was constructed by Governments exclusively, whether by the aid of the Imperial Government or by the Colonial Governments alone, they would only have to supply telegraphy to the commercial world at the cheapest possible rate, raising a sufficient amount of money to pay the interest on the money invested. There would be no promoters' fees to pay, there would be no striving after a large amount of receipts. He was one of those who believed that while the old saying about trade following the flag was literally true, at the present day it was as necessary to have telegraphic communication between the different parts of the Empire as it was to have ships to do the business. The resolution was carried unanimously with the alteration suggested by Sir Mackenzie Bowell. Mr. Plummer (Newcastle and Gateshead) moved, "That, so far as possible, it is most important that inter-Imperial postal and telegraph routes should be established between this country and the Colonies, as well as between the Colonies themselves, without such routes passing through other countries." Mr. Coates (Ottawa) seconded the resolution, and it was carried unanimously.

Central Technical College.—On Friday last a conversazione was given at the Central Technical College of the City and Guilds of London Institute in Exhibition-road, South Kensington. There was a very large number of guests. The Lord Chancellor (chairman of the council) and Lady Halsbury held a reception in the library, and among those present were noticed Sir Frederick Abel (chairman of the Executive Committee), Sir Frederick Bramwell, Sir Owen Roberts, Mr. John Watney (hon. secretary), and Profs. W. C. Unwin, Armstrong, Ayrton, Henrici, Kipping, Moody, and others directly connected with the college, while the City Guilds, which have so honourably contributed to its support, were represented by masters of several civic companies, Mr. Sheriff and Mrs. Cooper, and Mr. Sheriff Pound. Sir Owen Roberts, Sir H. and Lady Knight, Sir Walter Prideaux, Sir William and Lady Flower, Sir Douglas Galton, Sir Arthur and Lady Arnold, Sir John and Lady Donnelly, Mr. Crookes, Dr. Frankland, Profs. Kennedy, Tilden, Lockyer, Herring, Reinold, and Gladstone, Dr. Hopkinson, Dr. Garnett, and Prof. Silvanus Thompson were also there and very many others whom the writer did not see or did not recognise. During the evening the National Hungarian Band played in the main hall, and a concert arranged by Dr. Lapworth and other members of the chemistry department was given in the lecture theatre. As to the serious part of the business, any attempt to describe within reasonable limits of space what was to be seen would degenerate into a mere catalogue of apparatus and instruments. There were, as a matter of fact, something between 70 and 80 rooms of them, and professors and students ready to explain anything to anybody. In the basement were to be seen the boilers, engines, and dynamos, with the measuring and testing instruments relating to them. Somewhere down there we noticed the "injector" with which Messrs. Beeton, Taylor and Barr made their investigations into the effects of varying the form of alternating-current curves. It was not, however, in action. In the mathematical and physical departments were several new apparatus which have recently been described at the Physical Society. Prof. Ayrton and Mr. Mather's magnetic testing apparatus requires some description, and must form the subject of a separate note. In one of the mathematics rooms was a fine collection of instruments, including planimeters and integrators, harmonic analysers, integraphs, and so on. A lady asked if she was expected to understand all these, and was told that it was quite easy. There were about five different calculating machines ready to multiply for visitors to any reasonable extent, not to mention slide rules in various forms. It was consoling, however, to the mere fallible human being to see that with at least one of the machines it was possible for a clumsy person to get a wrong answer. The Röntgen photography appears to continue as much the rage as ever. Prof. Ayrton had something like half a dozen fluorescent screens and tubes going in a dark room, and as soon as the visitors found out where it was they simply crowded it. There was another room devoted to the same subject upstairs. A noticeable exhibit, also upstairs, was the apparatus with which Mrs. Ayrton has made her investigations into the fall of potential across the arc. The image of the arc and the mirror spots of the instruments are reflected back on to a screen in such a way that, as Mrs. Ayrton explained, "you can do the whole of the work without moving from your chair." Higher up there was an exhibition of art wood-carving done by past and present students. At the extreme top of the building was the crystallography room. Few reached it, but those ladies who did were much interested in the (model) gems. On the other hand, the anorthic crystals appeared quite at a discount. There were specimens of naphthalene derivatives prepared in a research of Mr. Ripping's, which is still in progress. This conversazione was the first time since very early days that the classrooms and laboratories of the college have been open to inspection in working order, and the occasion was an exceedingly interesting one.

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MUNICIPAL ELECTRICAL ASSOCIATION.

(Continued from page 661.)

On Friday morning a business meeting was held at the Royal United Service Institution, and the following programme for the ensuing year was arranged:

Place of meeting for 1897.—Manchester.
President.—Mr. C. H. Wordingham, city electrical engineer, Manchester.
Vice-Presidents.—Mr. Victor A. H. McCowen, city electrical engineer, Belfast; and Mr. F. Newington, city electrical engineer, Edinburgh.
Committee.—Mr. Arthur Wright, past-president, Brighton; Mr. Wm. Arnot, past vice-president, Glasgow; Mr. A. H. Gibbings, Bradford; Mr. A. B. Mountain, Huddersfield; Mr. John H. Rider, Plymouth; Mr. T. P. Wilmshurst, Halifax.
Hon. Treasurer.—Mr. G. H. Cottam, Hampstead.
Hon. Secretary.—Mr. A. B. Mountain, Huddersfield.

It was unanimously resolved to present to Mr. Wm. L. Madgen, who has been acting as hon. secretary during the period of organisation and the first convention, the best thanks of the members for the invaluable help he has rendered in the formation and organisation of the association, and, as a record of their appreciation, the resolution is to be suitably engrossed and presented to him, with a bronze to be selected by himself.

Visit to Brighton.

No more agreeable and pleasant manner of ending the first convention could have been suggested than that of a visit to Brighton, whose electric lighting undertaking is under the command of the association's first president. The party were received at the Royal Pavilion by the Mayor (Alderman Blaker) and the Electric Lighting Committee of the Corporation, headed by the chairman, Councillor Stafford, J.P. All the members and visitors having assembled, they were photographed in a group on the east lawn. An adjournment was then made to the music-room, where the chair was taken by the Mayor. He was supported by the president and the members of the Electric Lighting Committee.

The MAYOR said it was his first duty, as representing the citizens of Brighton, to extend to them a very cordial welcome to the town. They would be very pleased to show them any works belonging to the Corporation which might interest them, and he hoped they would be able to stay the night so that they might see the light in the streets. With regard to the undertaking itself, he freely and candidly admitted that when the consideration of the matter was before the Corporation he did his very best to oppose it. He felt, and many others felt with him, that they were rushing into the unknown and might be incurring any amount of difficulties hereafter, but he was glad now to say that he had made a mistake. Their success was well known. They had spent about £150,000—or rather they had invested that amount—and he had no doubt from what he had seen that it was a good and a proper step for the inhabitants, by their representatives, to take in acquiring the electricity works themselves. They all acknowledged their indebtedness to the municipal electrical engineers and those who worked with them throughout the country, but they were not satisfied. They wanted to be carried by electricity, they wanted their food cooked by electricity, and they wanted even to fly by electricity. He concluded by again according them, on behalf of the citizens of Brighton, a most hearty welcome.

Councillor STAFFORD, on behalf of the Electric Lighting Committee, supplemented the Mayor's remarks. He said he was not an expert; he was a business man, and he should speak with reference to the commercial undertaking, as he regarded it in Brighton. Their success had been owing to their progressive policy. They had gone in for catering for the million, so to speak, rather than for the rich residents of Brighton. They had done their utmost to cater for the ratepayers who backed their Bill. Those of the ratepayers who used the current were benefited by the roduction in price, making electricity almost as cheap as any illuminant, or quite as cheap if they considered the saving in the wear of decorations. And the other class of ratepayers, though not assisting them by consuming the current, were benefited by reduction of rates, for last year the electricity undertaking saved a penny rate. The committee were ready to lay down mains where there was any probability of their paying, and he might say that the large houses were not so much benefit to them as shops and even small houses in thickly-populated districts, while the hotels were almost their best customers. He congratulated the association on their choice of a president, and joined with the Mayor in heartily welcoming them to Brighton.

Extensions to Outlying Districts.

Mr. A. H. GIBBINGS, electrical engineer, Bradford, read an abstract of the following paper on this subject:

Some three months ago, when asked by your committee to contribute one of the papers for discussion at the first convention of our association, the writer was much interested in the consideration of this subject. It is one which is becoming of increasing importance day by day, both to the municipal electrical engineer and the municipality, and to each it presents many interesting and many novel features. The extension of electricity supply from the central station to the outlying districts of a township has, however, already become in very many cases a matter of urgency, and while there always exist distinctive features in each case, there are also many points common to all which may be considered with advantage. Considerable difference of opinion exists as to the comparative economy of the various methods of supply; but this is a point upon which, for the purposes of the present paper, we can well afford to agree to differ, because it does not in any way affect the main question now before us. The municipal electrical engineer is face to face with the problem of extending the supply in the most economical and satisfactory way; the town councillor has before him the demand for the supply from the members of his constituency in outlying districts. Let us deal with both sides of the question from a general point of view. The chief considerations apply equally to all municipal electric light undertakings, irrespective of the particular system adopted in each borough.

There are at present in operation in England, Scotland, Ireland, and Wales about 51 municipal electric light stations, and those towns which have already obtained their provisional order, and have electricity works in course of construction, number about 20, making a total of 71 municipal electric light enterprises in the United Kingdom. Of the above number 19 have been in operation over three years, and it is generally after the lapse of this period that the necessity to extend the hitherto confined area begins to be felt. The word "necessity" is used advisedly, because it accurately describes the situation, both as regards the majority of the ratepayers and the business itself as a trading concern. The period of three years is really too long to delay the actual extension of the mains; the writer is inclined to curtail the time by 12 months, for reasons which will be put forward towards the end of this paper.

Having decided that the necessity for extension will surely arise, *nolens volens*, the points to be considered may be stated to be—(1) the cost of extending the supply; (2) the effect on the cost of production and revenue; (3) the advisability of extensions.

The Cost of Extending the Supply.—Priority is given to this particular phase of the subject, as, very naturally, it is the one upon which great stress is laid by electric light committees. It is often made the most important point, other aspects being considered secondary matters. Unfortunately, too, comparisons are only made with what has been the cost of supply in the central portion of the town. It can be shown, however, that such comparisons are incorrect, and that too great prominence is often given to the initial cost of extensions. The cost of extending the supply is affected by—(1) the method of laying cables; (2) the characteristics of the suburban or outlying district; (3) the extent and class of demand. By the method of laying is meant the system which in economy and efficiency is found to be most satisfactory when the character of the suburban district, and the extent and class of the demand, are taken into account. It is, therefore, essentially a question to be decided for each district separately, by each town individually, considered with reference to the general system of electrical supply adopted by each. But, after all this has been said and emphasised, it is also universally true that many of those items which form so large a part of the cost of laying mains in the centre of a town are very much modified, if not entirely eliminated, in connection with the extension of mains in the suburbs. Such items are: (1) the reinstatement of footways and road paving; (2) the necessity for making ample provision for future demands by laying additional conduits; (3) the avoidance of obstacles under the footways and roads. It is not necessary to enlarge upon the very different effect which these items have upon the cost of laying the mains in the central and outer districts respectively. One or two illustrations will suffice. Attention is drawn to them merely because in some towns the difference will no doubt be very

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much greater than in others. In the matter of reinstatements, the cost of different paving is given in the following table for towns differing in size, position, and configuration.

COST OF REINSTATEMENTS PER YARD RUN. (About 2ft. wide.)

Town.	York stone, including new stone.	Patent asphalte.	Compo. Stone.	Granite setts and concrete.
City of London	3s. 8d.	Footway 6s. 4d. / Roadway 11s....	—	7s. 6d.
Hove (Sussex)	1s. 6d.	3s.	3s.	--
Hull	2s. 7d.	—	—	6s. 5d.
Bradford	3s. 8d.	—	—	8s. 4d.

From this table it will be seen that the cost of reinstatements varies considerably, but the figures also indicate the width and depth of trench made, and from this it may be inferred that more or less provision has had to be made at the time of opening for future extensions. A proportion, therefore, of the cost of reinstatement of conduits and cables laid really represents capital already spent for an extended supply, capital lying idle until a revenue is derived from outside. The method of laying cables in the central area is very naturally determined by the conditions referred to above, but where such conditions do not exist, as in the outer districts, other methods of laying mains may be adopted, by which the cost may be still further reduced when compared with that involved by the original method. For instance, in the case of a low-tension supply the first necessity of heavy feeders and distributing mains laid in expensive conduits might be substituted in the outer areas by armoured cables laid directly in the ground, or, in the case of high-tension, by a system of banked transformers substituted by direct supply to each consumer. The characteristics of the outlying districts and the probable extent and class of demand, considered in relation to the cost of extending the mains, may now be considered. Let us take these two items together, as the one depends very largely upon the other. In the very broadest sense these, of course, are really the determining factors with regard to the size and length of mains to be laid down. It can be shown that this may be ascertained as a very much more definite quantity than is possible when estimating the probable demand in the central area. The outlying districts may be scattered and thinly populated, or they may be the reverse. There are usually both instances in most towns. Scattered districts are likely to be composed of large houses, rich residential neighbourhoods, and unpaved streets ; in the second case, main streets leave the town, with a continuous run on each side of terrace houses, occasional shops, with a surrounding neighbourhood of side streets and residences.

Now, the very first advantage we have in considering the possibilities of supply in the above cases (and the consequent size of cables ultimately required) is the knowledge that, while the probable demand from business quarters is a greatly varying quantity, utterly impossible to forecast, in residential districts it may be comparatively easily gauged. Some shops in the centre of a town are let and relet in the course of two or three years, one tenant requiring eight or ten lights, another requiring no light at all, and a third demanding a supply for 40 or 50. This is only a typical instance of what occurs over and over again in the course of 12 months. Under such circumstances there is no basis upon which to work, and hence we have to be prepared for any demand. But it is different with residential houses. The annual rental is a safe guide, as the following table of rentals and corresponding gas bills, real and not imaginary, will show. The gas is 2s. 3d. per 1,000 cubic feet, and the length of the street is about three-quarters of a mile.

Description of property.	Annual rental.	Number of houses, shops, etc.	Aggregate amount of annual gas bills.	Average annual amount per house, etc.
			£ s. d.	£ s. d.
Shops only ...	£20 to £40	19	76 3 0	4 0 0
Do. ...	£40 to £50	2	11 18 0	5 19 0
Do. ...	£50 to £100	6	58 19 4	9 16 6
Houses only...	£20 to £40	24	91 8 4	3 16 2
Do. ...	£40 to £50	19	147 16 2	7 15 7
Do. ...	£50 to £100	50	506 0 2	10 2 4
Do. ..	£100 to £150	2	27 18 10	13 19 5
Houses and shops combined	£20 to £40	11	49 9 2	2 4 11
	£40 to £50	17	146 1 4	8 11 10
	£50 to £100	20	243 7 0	12 3 4
	£100 to £150	4	92 16 10	23 4 2
Hotels	£100 to £350	3	233 10 6	77 16 10
Theatres	£1,000	1	333 14 8	333 14 8

Each single account represented in the above summary showed, upon comparison, very little variation from one year to another, and therefore it should not be a difficult matter to estimate the maximum number of electric lamps likely to be required for many years in such a district. The table, of course, represents only one main street, but the illustration will serve for branch streets and abutting property. Hence, we can see how the characteristics and probable demand enable us to make accurate calculations, and so economise in the method of laying and the capacity of the mains. Now, it will readily be admitted that the points just dealt with are the very points which form the basis of comparison in estimating the relative value of one system over another. But, whatever the system, there can be no doubt that the cost of extending the mains can be very considerably reduced when compared with the cost of laying mains in the centre of the town.

The Effects on the Cost of Production and on the Revenue.—Supplying outlying districts with electricity appears at first sight simply to entail increasing the output at the central station, with a corresponding increase in the revenue. And the cost of production appears to be affected just in the same way as if the additional supply occurred in the central portion of the town. In reality, however, the effect on the cost and revenue is of a much more important nature, and it is this feature which gives the supply a relatively higher value. This is due entirely to the fact that the number of units consumed for a given maximum demand is very much greater in the outlying districts than for a corresponding demand in the centre of the town. In other words, private houses, small shops, etc., use the light for a greater number of hours than business offices and large shops within the central area. While the latter use a large number of lamps for a few hours a day, the former use only a few lamps, but burn them a considerable time. And so it comes about that the number of lamps installed cannot be made a direct and all-sufficient basis of calculation in estimating the probable revenue. We must also take into consideration the number of hours the lamps burn. Considerable assistance may be obtained in arriving at an approximately correct estimate if we know what is the general figure in lamp-hours per day in several towns. In the following towns the number of units sold per average 8-c.p. lamp connected at the end of 1895 is found to be as follows :

Town.	Units sold per lamp.
Hull	11·23
Aberdeen	12·85
Hanley	16·80
Leicester	17·46
Blackpool	18·05
Bradford	18·68
Manchester	20·60
Bristol	22·02

If we take these figures and reduce them to the number of hours per day during which the total number of lamps would be burning in order to produce the above annual ouput in units, we get the following result :

Town.	Watts per 8-c.p lamp per day.	Average hours per day per 8-c.p. lamp would be burning.
Hull	30	1 hour 0 minutes.
Aberdeen	35	1 hour 2 minutes.
Hanley	46	1 hour 32 minutes.
Leicester	48	1 hour 36 minutes.
Blackpool	49	1 hour 38 minutes.
Bradford	51	1 hour 42 minutes.
Manchester	56	1 hour 52 minutes.
Bristol	60	2 hours 0 minutes.

The average of these representative figures is 1 hour 33 minutes ; or, in other words, the total capacity of the station is being used for only 1 hour 33 minutes per day in producing the satisfactory results to which these towns have attained. There can be no question that the time during which the major portion of the revenue is earned is for the first two or three hours after dusk. A reference to any central-station load curve will prove this, and, further, that more than 50 per cent. of the lamps connected are not in use at all for six months of the year. Now, this is just where the private consumer comes in and fills the gaps. His lamps, although adding to the plant capacity at the station, also increase the average earning capacity, and in the proportion estimated in the following instance. If we assume that an equal supply is demanded by the central and the outer districts respectively, then, of course, the plant capacity at the station would be double that required for the central portion only ; and if both classes of the demand were like that in the central area, the whole plant would still be earning its entire revenue in 1½ hours per day. But it may be safely assumed that 75 per cent. of the demand in the outlying districts will be continued from 7 to 11 p.m. on an average throughout the year, or, say, for fully four hours longer than the central portion. Now, 75 per cent. of half the maximum demand is equivalent to a little above one-third of the maximum demand continued fully for four hours, and this is, of course, equal to the full demand continuing for 1¾ hours. It will at once be seen from this simplification of the matter that the earning capacity of the plant has been increased from 1 hour 33 minutes to 3 hours

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18 minutes, or more than twofold; or, in other words, the number of units sold are doubled for the same maximum demand. But what is true of the whole is true of a part, and hence the earning value of every 8-c.p. lamp connected in the outlying districts is three times as great as that of a corresponding burner in the central portion of the town. In addition to this relatively higher value of the residential supply as compared with the shop and office supply, the former would be required very largely on Sundays, thus giving an additional 52 days' consumption on the year. It would also form a better load on holidays, and during the winter months from 6 a.m. to 8 a.m. For all these reasons such a supply is eminently desirable.

Having determined the relative value of the demand from the residential districts, it is an easy step to ascertain the effect on the cost of production and on the revenue. The cost of production is made up of the actual cost of generation—viz., coal, oil, etc.—and the standing charges—viz., wages, salaries, repairs and maintenance, interest on capital, sinking fund, depreciation, rent, rates, taxes, etc. Taking the average of a score of central stations, the charge per unit is about as follows: generating cost, 1d.; standing charges, 3·5d.—total, 4·5d.

With a slightly increased efficiency of the generating plant that portion of the cost is likely to be slightly reduced, but it may be taken, nevertheless, to remain practically the same per unit—namely, 1d. But, assuming an equal demand in both central and outlying districts, the number of units sold for the same standing charges is doubled, and therefore this item of the cost would decrease in the same ratio—that is to say, the 3·5d. per unit would become 1·75d. and the total cost per unit 2·75d. instead of 4·5d. This at once opens up the possibility of a substantial reduction in the price: a reduced price would probably attract new customers, and thus, step by step, we might ultimately arrive at a universal adoption of the light. We can even imagine the demand from the outlying districts being twice as much as that in the central area (a very common feature of gas suppply) and in that case a general price of 3d. per unit would then be most remunerative. This, at least, seems to be certain, that every lamp connected in the residential districts has the effect of helping to reduce the standing charges in the ratio of 2 to 1, as far as its own consumption is concerned.

With the foregoing explanation it is easy to see what is the effect on the revenue. The price to the consumer remaining the same, 5d., 6d., or 7d., the revenue or net profit would be increased by exactly the same amount as the standing charges would be decreased. In the example given the standing charges would be decreased by 1·75d. per unit, and by itself this amount would form a very considerable net profit even if the average charge per unit was only 4½d. The average price obtained, however, by most municipalities is more than 4½d., and at that price a net profit is made of from 3 to 5 per cent. Of course, the object of the municipalisation of these undertakings is to supply electricity at as low a price per unit as is consistent with fairly paying expenses and providing for contingencies, but the price will never descend to a popular figure while the supply is confined to the central area. The possibility of a reduction commences, however, as soon as the many-hours private householder has the opportunity of using the light. Such a reduction should take place naturally and gradually as the demand in the other districts increases, and when we remember that every lamp supplied there brings in the same revenue as three in the central portion, the effect on the profits of the department would not be long in becoming apparent.

The Advisability of Extensions.—The writer has endeavoured to show that, as a question of finance, extensions would probably be very remunerative; but there is, of course, still another factor to be taken into consideration, and that is the rate at which consumers will avail themselves of the new light in these districts. The same uncertainty existed not so many years ago when the public supply of electricity from a central station was first commenced. At that time, too, there were many other problematical features which do not exist to-day; there were obstacles, prejudices, conflicting interests, which have since been overcome. And the responsibility of such an enterprise as a wholly new undertaking was beyond all comparison greater than any question which electric lighting committees are now called upon to consider. The venture then was almost entirely speculative, owing to the absence of fundamental data, and in many instances (notably Bradford, the first municipal central-station supply) the business was started to keep out a private company. The success which has been met with, however, has been beyond expectation, and this fact is in clear evidence by the present 51 corporation electricity supply undertakings, and by the efforts of several other municipalities to buy up the rights which they have so recently allowed to fall into the hands of private companies. These rights and undertakings will undoubtedly have to be paid for very heavily before the corporations become possessed of them. Yet in the face of these practical experiences we still hear of towns and parishes such as York, Barrow, Lambeth, etc., which are fighting the same old battles and traversing the same dreary ground about the establishment of electricity works as the pioneer municipalities encountered many years ago.

We might reasonably infer, I think, from what has been the experience in regard to the central area—viz., that while it was difficult to forecast the probable demand, yet the result has been a very general adoption of the electric light—so with regard to the outlying districts, the result should be an equally steadily-increasing demand. As to the probability of this deduction being verified, I am able to give an instance in point. In 1893 the Bradford Electricity Committee canvassed, among other districts, the street to which I referred in the second section of the paper, and for which I have given the representative annual gas bills. This canvass was a personal house-to-house enquiry, but not a single individual would give a guarantee to take a supply. The price per unit was the same as at present—namely, 5d. In June, 1894, the committee made a further effort by means of a circular letter. Very few replied, and only one individual definitely promised his patronage. At the beginning of this year I brought the question again before the attention of the committee, and advised them to lay the mains as a matter of speculation, and they so far conceded as to grant the extension for three-quarters of a mile. Of course, in face of what I may call the negative results of the canvass, this was a great and bold step to takes. When this was known to the wiring firms, they on their own account immediately canvassed the street, but in one month only succeeded in getting three applications, with a total of 70 8-c.p. lamps. A month later we commenced to lay the mains, the wiring firms in the meantime continuing to solicit orders, but without success, the general excuse being a desire to wait until the mains were laid. So the mains were started with three promised customers. Before the entire length was laid, however, the number had increased to 10, demanding a maximum supply of 210 8-c.p. lamps; and as an instance of what a little judicious speculation will do, the number at the end of May, or one month after the mains had been completed, was 16, with 260 8-c.p. lamps connected. Now, I think this instance is a very good argument against relying to any extent upon canvassing. Of course the streets with which to commence the extension have to be selected with discretion, but once started, a supply will soon be demanded over the entire area of the borough.

I mentioned in the first part of this paper that I considered two years a sufficient period after the establishment of the electricity works to initiate a scheme for the supply to the outlying districts. My reasons for naming two years are twofold. First, at the end of that period the supply will probably have become generally known and appreciated, and the financial position of the undertaking is generally sound and good. Secondly, I think it very desirable that the inner and outer districts should then grow simultaneously. The load curve would thus be improved, and the probable future needs of the town would be more readily gauged and satisfactorily provided for than would be the case if the extension were long delayed.

To sum up the whole matter: To me it appears that at the present time the great object for municipalities to aim at is the reduction of the price at which electricity can be supplied. I contend, and have endeavoured in this paper to justify my contention, that this object is attainable. Not only so, but that it may be attained in a most satisfactory manner by developing the enterprise. Like the railway companies of old, I have every confidence that we should go forward—certainly not in a headlong spirit of reckless extension, but, on the other hand, with an unhesitating and deliberate movement of advance.

Discussion.

The **President** said the association had happened to come to a town where the policy advocated by the Lighting Committee amply bore out the conclusions arrived at in the paper. In Brighton there was hardly a house that was not within a quarter of a mile of some electricity distributing main. The committee saw the necessity of pushing these mains out to districts long before promises for taking the current were obtained. They found, as Mr. Gibbings stated, that it was no use canvassing districts before they put the mains down; the mains themselves were the best canvassers. He agreed with Mr. Gibbings as to the importance of the private-house load to the central station. When the central part of the town had finished its work the inhabitants migrated to the outside, and it was this demand later in the evening that was so useful in lessening the cost of supply. However, it seemed to him putting the case too high to say that a lamp in a private house was worth three times the value of a lamp in a shop. They found as the result of their practice at Brighton that the number of hours a private-house consumer used his light was practically the same as the shop—namely, two hours a day throughout the year, but owing to its being at a later period, it was better than the shop. On the other hand, the shop lights were very regular, and the private-house lights very irregular.

Mr. Giles said that in Blackburn they found it impossible to continue their low-tension mains in such straggling districts as theirs. They used the high-tension alternating supply. The consumers living a long way from the mains had agreed to pay 6 per cent. of the cost of laying the mains to them; the payment was limited to 16 years. There was also a reduced interest if anyone else came on their service.

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Mr. Higginbottom said they had seriously considered this subject in Manchester, and even now were applying for parliamentary powers whereby in one direction they would have to go nine miles and in another seven miles, and they would be bound to cover these areas in two years. He did not agree with the policy of the last speaker as to charging a rent upon the mains taken into a new district for the supply of any particular house. It was unfair to those ratepayers who required it, because in the event of a loss on the undertaking it would come upon the rates, and those ratepayers who paid extra for the light would also have to pay their share of the deficit. In Manchester wherever a customer had asked them to go they had gone.

Mr. Dixon was also an advocate for laying down the cable and letting it advertise itself. In Bradford they had adopted the opposite policy, and sent out circulars, and it had all amounted to nothing, but directly they laid down the cable the applications came in faster than they could deal with them.

Mr. Mountain remarked that the lamps from the residential district did not bring in so much as the shops, and yet the residential portion was the only portion at the present time which was paying.

Mr. Manville contended that the question was best solved by using a low-tension current for the central district, but let it be an alternating one and not a continuous one.

Mr. Boot (Tunbridge Wells) said that in the town he represented the mains had been extended very rapidly after the first working. For some time they had more residential houses taking the light than shops, and they could not have supplied these lamps unless they had adopted the policy of extension wherever the demand arose.

Alderman Norman said that in Cheltenham their customers were very much scattered, but the Corporation advocated the policy of extending the cable wherever required free of cost to the consumer.

Mr. Wordingham, on being asked by the president how they were going to deal with this question in Manchester, said he really did not know. It seemed to him necessary to get the work done by one station or as few stations as possible. To get that on one station for a very large district implied some form of high tension. He disagreed with Mr. Manville that they should do it with alternating currents, and argued strongly in favour of the continuous current. His view was that they should put down a station which should supply the immediate district at as high a volt pressure as possible—that was, 400 volts. For the immediate neighbourhood of the station they should use the five-wire system; for the residential district they should use the three-wire system for 200 volts; and for the outside places they should use high-tension—say, at 3,000 volts continuous—to be transformed up from the 400 volts and then transformed down again on the distributing mains. Their system must be, he thought, a portion low tension and a portion high.

Mr. Quin (Blackpool) gave some interesting figures as to the cost and details both as to Blackpool and also Brighton, which town he has lately left.

REPLY TO DISCUSSION.

Mr. Gibbings, in reply, said he was sorry to see that the discussion had degenerated into a question of system. With regard to the system he could only say that that must be left to each engineer to work out according to his requirements. As regards the cost, when he said it would be likely to be less in the outlying district, he did not mean to infer that it was necessary to lay cables half a mile or three-quarters of a mile directly a customer applied for it.

Votes of Thanks

On the proposition of Mr. RIDER, seconded by Mr. ARNOT, a hearty vote of thanks was passed to the Mayor and Corporation of Brighton for the loan of the Pavilion, and for their cordial reception.

By the generosity of the chairman of the Lighting Committee, tea and refreshments were served in the north drawing-room. The members afterwards made an inspection of the works in North-road. These are being erected for the Corporation by Messrs. W. A. Field and Co., contractors, of Brighton, from the designs of the borough engineer and surveyor, Mr. F. J. C. May, and the comparison of the size between the old buildings, which were erected only a very few years ago, and the present extensive structures very forcibly illustrates the success which the Corporation have achieved by adopting a "progressive" policy. The chimney shaft, which is of handsome design, and which is about 220ft. high, with an internal diameter of over 13ft., is quite completed, and the boiler-houses, engine-rooms, offices, etc., are receiving the finishing touches. Mr. Arthur Wright and Councillor Stafford, with other members of the Lighting Committee, were present, and gave every information to the visitors.

On Saturday morning, at the invitation of the engineer to the Hove Electric Lighting Company, many of the members visited the new station which has recently been erected in Goldsmid-road.

ERRATUM.—In our last issue we announced Mr. Panton as "representing the Electric Light Committee of Bolton." This is erroneous, and Mr. Panton writes to say that he is not a member of that committee, and was not their representative in any way.

HANLEY.

At a meeting of Municipal Engineers at Hanley last week Mr. J. Lobley, M.I.C.E., the borough engineer, in the course

J. LOBLEY, M.I.C.E., BOROUGH ENGINEER, HANLEY.

of a paper upon recent municipal work at Hanley, made the following remarks concerning the electricity works:

Hanley Electricity Works.—A provisional order was obtained in 1891 enabling the Corporation to lay down mains and erect buildings and plant for the supply of electrical energy within the borough. The author visited America in the autumn of that year, and made special visits to the electric lighting stations in towns of about the same size as Hanley, in order to make himself acquainted with the general business engineering arrangements required. It will be remembered that at that time there were very few examples of that description in this country. The designing and carrying out of the buildings, lines of mains, erection of generating plant, and all works in connection therewith, has from the first been entrusted to the author. In September, 1892, the Council entered into a contract with the Brush Electrical Engineering Company for the boilers, engines, dynamos, mains, and sub-station transformers requisite to deal with the compulsory area lighting, both public and private, in its first stages; the system adopted being that known as high-pressure alternating current, with transformers at sub-stations, from which low-pressure distributing mains are laid to consumers' premises. The reason that influenced the Council in selecting this system as against a continuous-current scheme, as being more suitable for a district like Hanley, were principally: (1) the works could be placed away from the centre of the town, and where land is less valuable, and where, consequently, extensions could be more readily made as required; (2) the north-eastern corner of the park estate, adjoining the canal, was available as the site for the electricity works, and will be found to be very conveniently situated and but little removed from the actual centre of the area of supply. Further advantages accrue from its proximity to the canal for the supply of coal and water for condensing engines. The high-pressure mains are concentrically arranged in one cable with insulating material between the two sets of copper strands, the whole being insulated and protected by outer coverings. This cable is drawn into cast-iron pipes, forming a ring main from the works *vid* Bethesda-street and Piccadilly and the Market-square, and returning *vid* Tontine-street and Lichfield-street. The low-pressure distribution mains are not concentric, but are laid double in cast-iron troughs, afterwards filled up solid with pure bitumen. The capacity of these mains is practically increased to any extent desired by reducing the

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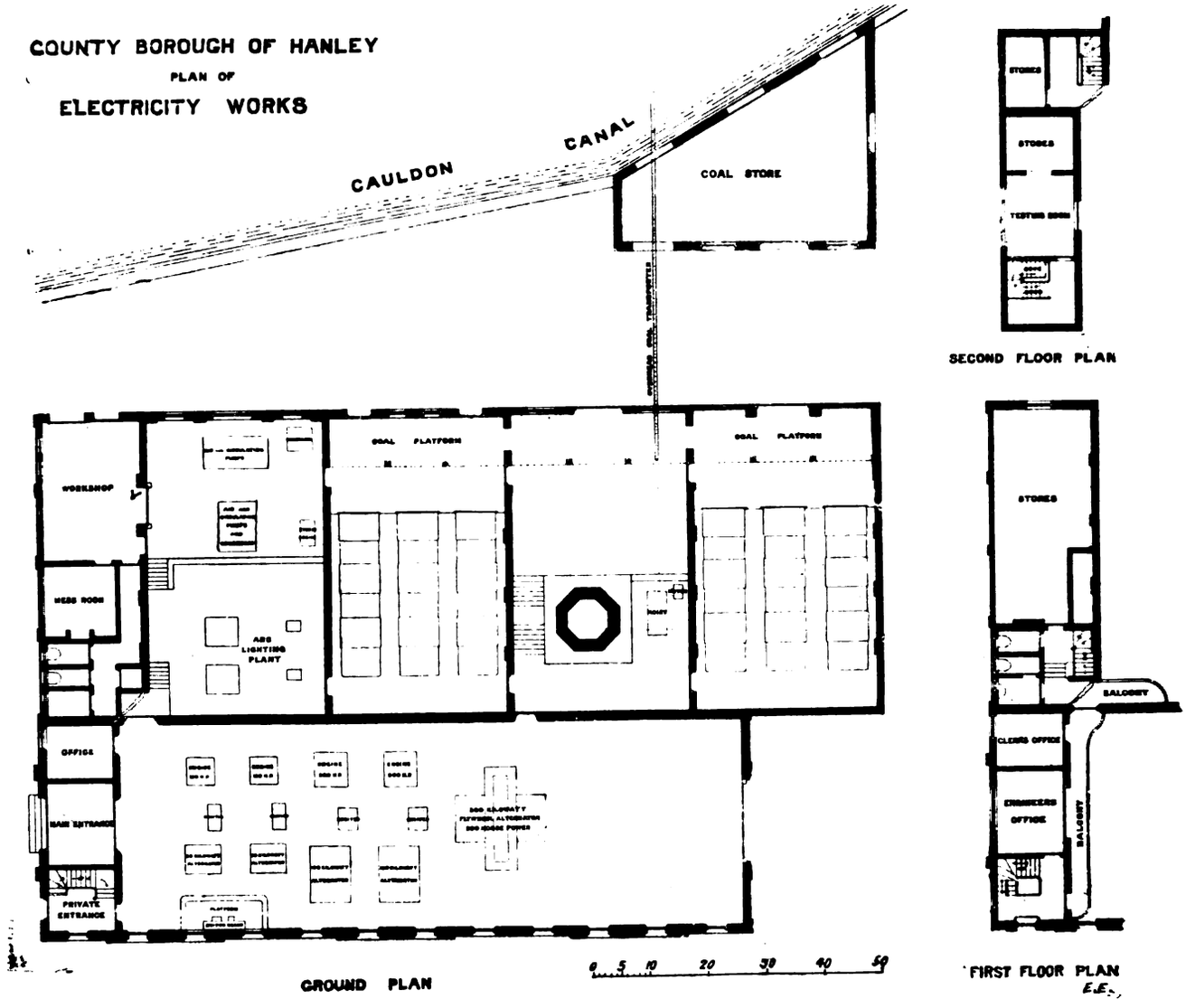
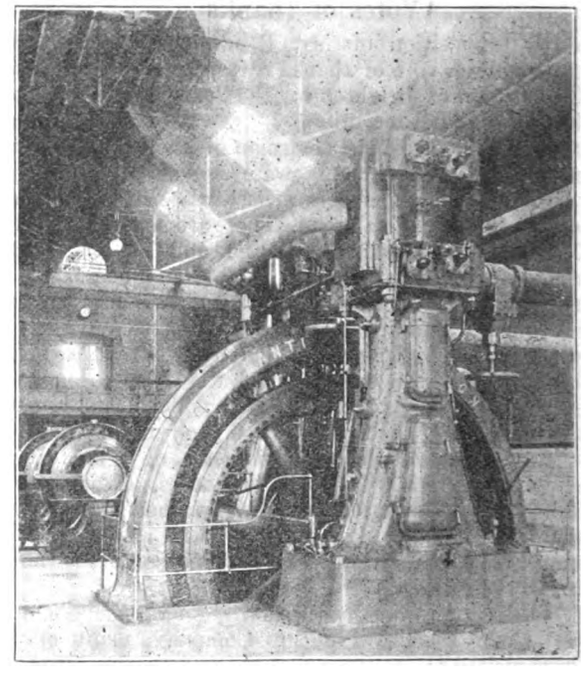
area served by them. This is done by adding transformer stations at the points of most demand.



Public Street-Lighting (within or adjacent to the compulsory area).—The contract includes provision for 30 arc lamps of 1,200 n.c.p. each—*i.e.*, 400 watts. These are arranged in series, supplied with electricity by a special cable from a continuous-current dynamo. A second engine and dynamo is provided as reserve.

Incandescent Lamps for Side Street-Lighting.—Within and adjacent to the district through which the electric light mains pass are other existing gas lamps, in addition to the 53 lamps of various sizes that were dispensed with by the establishment of the 30 arc lamps. At present it is generally conceded that arc lamps should be used for leading thoroughfares, but there are many positions, particularly in side streets, where the establishment of such a lamp is out of the question, and where an ordinary gas-burner or a 60-watt (16-c.p.) incandescent lamp would suffice. There has been laid in the same cast-iron trough with the general supply mains two separate insulated cables of small size, the whole being afterwards filled up, as before described, with bitumen. The author has devised an arrangement for lighting incandescent gas lamps in parallel without sending round the lamplighter. Where arc lamps exist in series controlled from the central station and have independent continuous-current plant and cables, the arrangement is as follows: The arc lamp cable is passed through the apparatus (which is placed at sub-stations), and whenever the arc lamp current is turned on the apparatus switches on the current from the general supply low-pressure mains to the incandescent lamps arranged in parallel. These should not exceed 20 16-c.p. lamps off one connection, so that the distance of the furthest lamp should not exceed 200 yards. When the arc lamps are turned out he apparatus switches off the current supplying the incandescent lamps, which are thus automatically lighted and extinguished by closing or opening the arc light circuit at the electricity works. The apparatus consists of a solenoid or electromagnet operating a lever; the



500-h.p. Ferranti Plant at Hanley, showing Brush Alternators in Background.

current of the arc lamps energises the solenoid or electromagnet, lifts the lever, and by a mercurial or other switch

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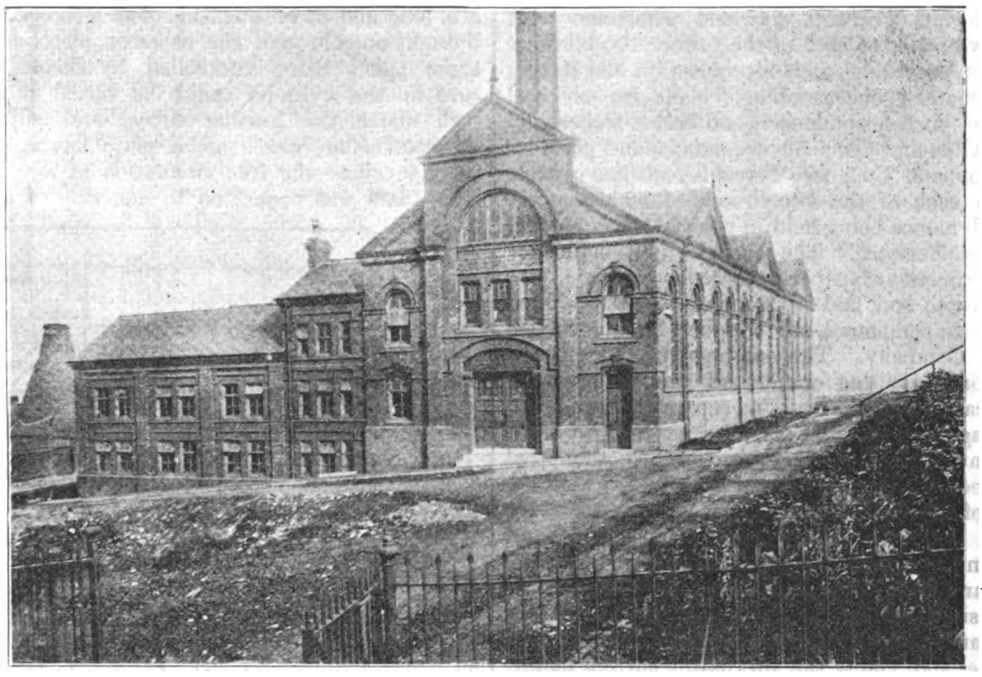
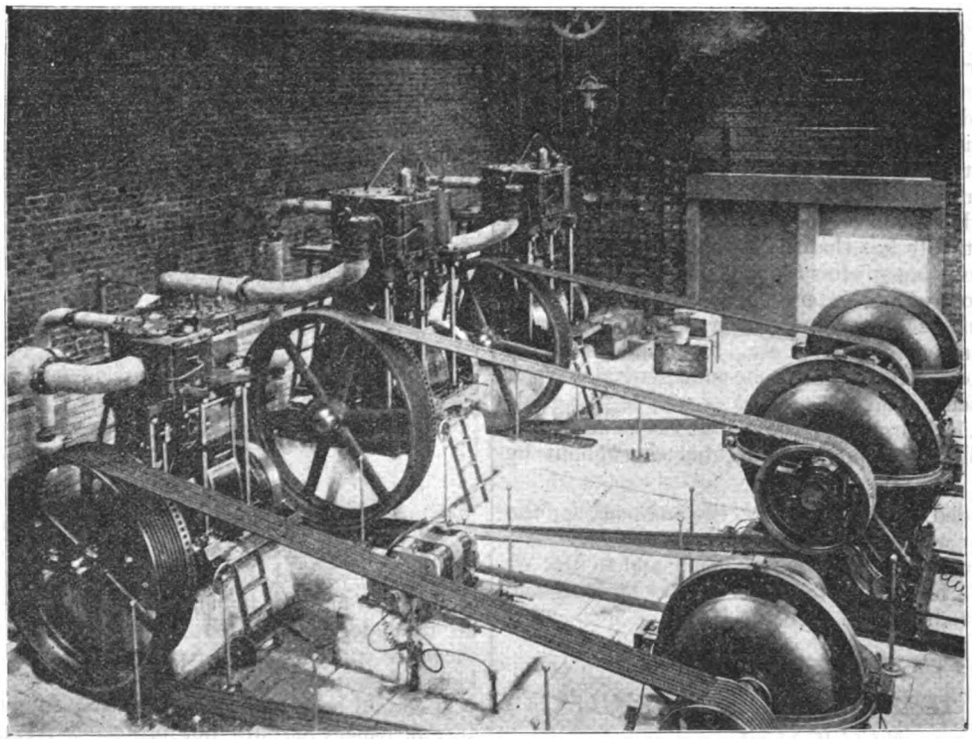
closes a low-pressure circuit for the incandescent lamps. The author believes that incandescent lamps in parallel for street-lighting has not received the attention the method deserves. He has seen many complicated arrangements of lamps in series. There are now in operation several lamps arranged as above and working satisfactorily.



Hanley Electricity Works.

No switches of any kind or "cut-in" arrangements are requisite at the lamp-post. Within half a mile of the works it is proposed to try a modification of this system devised by Mr. Sutherland. In the new roads round the park the special cables will be supplied with current at 300 volts, switched on when required at the works; in each lamp-post three lamps, 8 c.p. and 100 volts each, will be placed in series, the group of three being in parallel off the special mains. The cable used is twin lead-covered equal to 7-20 S.W.G., and even if series lighting was used it would not be advisable to use a smaller conductor than that. The first loans sanctioned were as follows: electricity works, buildings, generating plant, mains, etc., for dealing with the compulsory area of 35 acres in the centre of the town, £21,000; meters, etc., £1,000; wiring Corporation buildings, £3,000. Current was first supplied in April, 1894, and the works formally opened in the following July. The plant and mains were capable of supplying 10,000 8-c.p. lamps, and before the end of that year the demand had exceeded the safe limit, and rendered it imperative to extend the works and mains. Additional sanctions were obtained amounting to £24,000, the capacity of the works both for public and private lighting being doubled, and the mains commanding an area of 400 acres. Supply can be given to all applicants along the entire length (1¾ miles) of the main road through the borough, from Stoke Station on the south to the Burslem borough boundary on the north. The generating plant first erected was as follows: three Lancashire boilers, each 28ft. by 7ft., working pressure 120lb. per square inch; four vertical compound condensing engines—namely, two 200 i.h.p. and two 100 i.h.p.; four alternating-current dynamos—namely,



View of Dynamo-Room at the Hanley Electricity Works.

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two 100, and two 50 kilowatts—each driven from engines by ropes; separate compound engine for air and circulating pump and surface condenser; two dynamos for street arc lighting, driven from two vertical compound steam-engines of 30 i.h.p. each; two 10-kilowatt continuous-current exciters driven by belts each from one of the 50-kilowatt alternators. The plant erected for the extensions consists of one 300-kilowatt Ferranti flywheel alternator with exciter, one new exciter to each of the former 100-kilowatt alternators, thus providing each alternator in the station with its own exciter; one combined plant for air and circulating pump, surface condenser, and boiler feeders, by Messrs. W. H. Allen and Co.; 30 arc lamps and posts by Messrs. Crompton and Co.; two Ferranti rectifiers capable of dealing with each of the two circuits of 30 arc lamps, the former arc dynamos being held in reserve; new switchboard by Messrs. Ferranti. The electric light mains for the extensions consist of paper-insulated concentric conductors, lead-covered and laid in troughs, afterwards filled up solid with resin compound, all supplied by the British Insulated Wire Company. The engine-house is furnished with a seven-ton travelling crane, and the boilers with Cass's mechanical stokers, driven by separate engine, and two water-storage cisterns. A platform extends in front of the boilers at a level above their tops, so that coal can be discharged into the hoppers of the stokers with the least amount of manual labour. An arrangement for lifting the coal out of a canal boat or coal-shed and depositing it on the platform has been devised by the author and carried out by the Temperley Transporter Company, who supplied their speciality; Messrs. J. Warner and Sons, of Hanley, supplying the platform traveller, and Messrs. Bergthiel and Young the alternating-current motor. The author believes that it will meet the requirements of the electricity works better than the usual form of elevators, which are no doubt well fitted for places requiring a steady constant duty. Further, the transporter can be used for lifting the coal out of a boat and depositing it in the coal store sheds, or for unloading paving or other material from canal boat to cart. In carrying out the works the author has been ably assisted by Mr. G. H. Cottam, the Corporation electrical engineer, who had the running of the works in his charge until he received the appointment of chief electrical engineer to the Hampstead Vestry, and also by Mr. C. A. Cowell and Mr. C. J. Sutherland, who were appointed last September electrical engineers and joint managers under the general direction of the author. Regarding the financial aspect of the undertaking, the ratepayers have every reason to be satisfied with the prospects. Not only did the works conclude the first completed year on December 31, 1895, with a balance in hand after paying all expenses, including interest and redemption of loans, but on December 31, 1894, with practically less than six months' running, there was a favourable balance, after discharging all obligations, including a whole year's interest on loans. The price charged per unit is 5d.; current for motive power is offered at 3d., and to churches, etc., for Sundays, at 4d. The town hall, baths, free library, museum, general market, fish market, butcher's market, school of art, higher-grade school, St. Mark's Church, and the public clocks at the old town hall and Shelton Church are lighted throughout by electricity.

[We are indebted to Mr. J. Lobley, the engineer, for the plan of extension works, and to his son, Mr. F. J. Lobley, for the photograph of the dynamo-room; and to Mr. W. Hampton, F.C.S., for the photographs of the building and the new Ferranti alternator.—Ed. *E. E.*]

EFFECT OF TEMPERATURE ON INSULATING MATERIALS.*

BY GEO. F. SEVER, A. MONELL, AND C. L. PERRY.

Of the many kinds of insulation, a few of the most common were chosen—*i.e.*, paper, cloth, oiled paper, and oiled cloth—and the following conclusions have been drawn from the result of 102 tests on samples of materials which were kindly furnished by several of the most prominent manufacturers of electrical machinery.

The Apparatus.—The heating apparatus consisted of a glass cylinder 8in. in diameter and 10in. high, covered at the top and bottom with asbestos plates. The lower part of this cylinder was occupied by 12 enamel resistance tubes 5in. long and 24 ohms each. The terminals of these were brought out through the asbestos plate. The current in these tubes being controlled by rheostat, the temperature in the cylinder could be varied at pleasure. An inch above the heating tubes, and supported by an asbestos collar, was a metal plate having holes punched in it to allow the free circulation of air in the cylinder. This plate was connected to one side of a galvanometer.

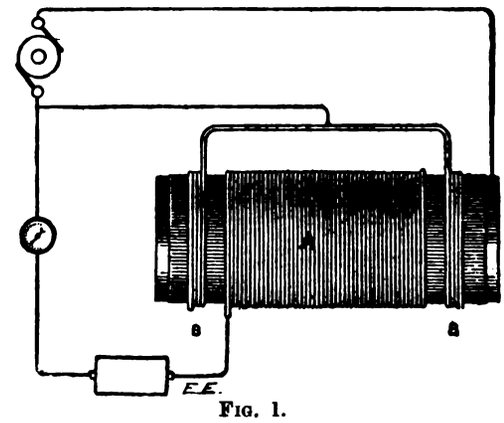

FIG. 1.

The insulating material to be tested was wrapped on brass cylinders ¾in. in diameter and 3in. long, the insulation not reaching quite to the end of the tube. The insulation was then wound with No. 26 B. & S. bare copper wire for a space of 2½in. A Thomson high-resistance galvanometer, a megohm box, and a difference of potential of 500 volts were used in the tests. The thermometer used was of the nitrogen-filled mercurial type, and capable of measuring from 0deg. to 400deg. C. When troubled with surface leakage it was eliminated in the following simple manner. The diagram shows the connections while testing a tube and also the leakage shunt. It will be seen from the diagram (Fig. 1) that all of the current going through the galvanometer must pass from the dynamo to the brass cylinder, and thence through the insulation to coil and on through the galvanometer. Any current tending to leak over the surface of the insulation from the brass cylinder to coil will be intercepted and shunted past the galvanometer by coils B B.

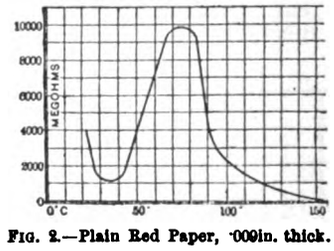

FIG. 2.—Plain Red Paper, ·009in. thick.

Plain Paper.—In this class 40 specimens were tested. After the resistance at the temperature of the air (22deg. C.) was carefully noted, the temperature was gradually increased (100deg. in one-half hour), and readings taken every 10deg. up to 80deg., and from there on every 20deg. Fig. 2 shows a curve which is characteristic of practically all kinds of plain paper.

It should be noticed, however, that in general the resistance of papers that are not protected from moisture falls between 22deg. and 50deg., and then rises rapidly until at 75deg. it has attained a maximum resistance. It should also be noted that this temperature of 75deg. is very constant for all kinds of paper. From 75deg. upwards the resistance falls rapidly, and at 150deg. is but a small fraction of its initial resistance. The initial resistance of paper protected from moisture by japan (Fig. 3) is very high, but falls rapidly with the increase of temperature, as

* Paper read before the American Institute of Electrical Engineers, May 20, 1896. Abstracted by the *Electrical Engineer* (New York.)

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is the case with all material protected from moisture. (See oiled paper and oiled cloth.) Hence we see that all paper having a porous structure, and therefore containing more moisture, has a lower initial resistance than the protected paper, but is affected by heat much less than the latter. This would lead to the conclusion that there are two phenomena taking place. First, the driving off of the moisture, which tends to increase the resistance, and, secondly, some change (not a mechanical deterioration) in the material dependent on the temperature, and which may be called the temperature coefficient. This temperature coefficient tends to lower the resistance with increase of temperature. Examing the several curves shown, we see that the initial resistance of unprotected papers is low on account of the presence of moisture. Now, on gradually

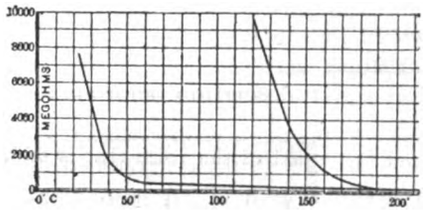

FIG. 3.—Japanned Red Paper, ·01in. Thick.

increasing the temperature the resistance falls during the first 20deg. or 30deg., because the effect of the temperature coefficient predominates during this period and before the material is warm enough to start the evaporation of the moisture it contains. This, however, lasts but a short time, as the result of the evaporation is to increase the resistance very rapidly, until at 75deg. the temperature coefficient again asserts itself and the resistance rapidly falls. In the case of japanned papers (Fig. 3) the initial resistance is very high, due to the absence of moisture, but on being heated the resistance drops rapidly as the small quantity of water contained is evaporated off so slowly that it has very little counteracting effect on the temperature coefficient. Paper does not seem to deteriorate mechanically at less than 180deg.; above this point the material begins to carbonise. At 230deg. a peculiar phenomenon takes place. The material after possessing a very low resistance from 175deg. upward, would at about 230deg. suddenly increase greatly in resistance and immediately after break down. This may be caused by some molecular rearrangement taking place at that temperature which changes the resistance of the material. Other cases wherein the resistance of a body changes at a certain temperature are well known, such as the recalescence of iron. It would seem that paper insulation has a critical temperature somewhat analogous to that of iron, steel, and nickel, but, of course, the characteristics of the materials are too different for any close similarity.

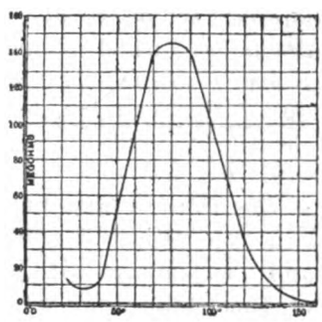

FIG. 4.—Plain Cotton Duck, ·015in. Thick.

Plain Cloth.—Under this head 20 specimens were tested, including canvas, linen, and muslin of different thicknesses. The action of this material (Fig. 4) is much the same as that of paper (Fig. 2). The initial resistance is lower, as it contains more moisture than is the case with paper; for the same reason, when the moisture evaporates off, the increase over the initial resistance is greater than with paper. By reference to the curves of paper and cloth, it will be noticed that their resistance varies in the same manner. For cloth, as for paper, the maximum resistance is at 75deg. C. The material does not begin to carbonise until at a temperature of 180deg. C., and even beyond that point it loses its mechanical strength very slowly until past 220deg.C. The explanation for the resistance of cloth varying as it does is exactly similar to that for paper.

Oiled Paper.—In this class 14 tests were made, on papers of different thicknesses. With the single exception of one specimen (the resistance of which was very high) the initial resistance was lower than in the case of paper. (Compare Figs. 2 and 5.) On increasing the temperature the resistance fell rapidly, the curve being much the same as that for japanned paper. The reason for the sudden decrease in resistance is the same as that for japanned paper. Oiled paper deteriorates mechanically at a lower temperature than paper or cloth, commencing to blacken at so low a temperature as 120deg. C.

Oiled Cloth.—In this class 28 specimens of oiled silk, muslin, and linen of various thicknesses were tested. The initial resistance of this material is much lower than that of paper, and on increasing the temperature the resistance falls rapidly, the shape of the curve (Fig. 6) corresponding to those of japanned and oiled paper. The reason for the sudden decrease in resistance is undoubtedly the same as for the japanned and oiled paper. The insulation begins to char at about 120deg. C.

General Conclusions.—In the foregoing discussion there are some main points to which it is necessary to draw attention. These are—(*a*) that paper is a better insulation and withstands increase in temperature much better than cloth (shellac and varnish were not used in any of the experiments), oiled paper, or rolled cloth. (*b*) That paper and cloth have a maximum resistance when first heated at about 75deg. C., and are not injured mechanically under

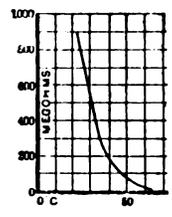

FIG. 5.—Oiled Paper, ·0045in. Thick.

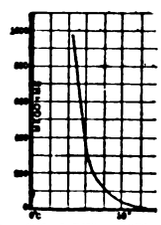

FIG. 6.—Oiled Silk, ·007in. Thick

180deg. C. (*c*) That the point of maximum resistance for paper and cloth (in this case 75deg. C.) depends on the rapidity with which the temperature is increased. The authors suggest that if the material were kept at a constant temperature until all the moisture had been evaporated the resistance of the material would then be its true resistance at that temperature. (*d*) That all give a high resistance after cooling, but have little mechanical strength. Oiled paper and oiled cloth, however, after having been heated to 220deg. C., and allowed to cool, not only have a high resistance, but become so firmly fixed to the brass cylinders that it was found necessary to remove them with a file. (*e*) That it would be well to bake paper and cloth insulation to 140deg. C. before applying varnish or shellac. (*f*) Referring to Fig. 3, it will be seen that on decreasing the temperature the resistance increased, but the second curve does not by any means coincide with the first. On further experimenting in this direction, it was found that there is no temperature at which the curve with falling temperature coincides with the first. This may be due to more moisture being driven out at higher temperatures which is not absorbed by cooling.

Here it may be well to mention an interesting phenomenon that occurred in connection with this investigation. When the temperature has risen above 100deg. C., the zinc in the brass cylinder begins to leave its surface and combine with the copper wire wrapped about the insulation, so that the wire has a brass surface and the brass cylinder a copper surface.

Sale of Electrical Machinery.—In this issue Messrs. Bradshaw Brown, Hooper, and Price advertise that they will sell by auction on June 30, at 11 for 12 o'clock, various engines, electrical plant, etc. The sale will take place on the premises of the London and Lancashire Electric and General Engineering Company, Kingsland-green, Dalston Junction, N.E.

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KELVIN.

Glasgow in the first instance specially—accompanied by the whole world of contemporary science and learning as well as those who sit in high places—has during the past week been proud to do honour to Lord Kelvin. For fifty years has Lord Kelvin filled the professorial chair at Glasgow University; for fifty years and more has he stood in the forefront of science. Glasgow in the first place celebrates the jubilee of her renowned professor. We all ask to combine in the celebration of this jubilee as being in honour of one of the world's intellectual giants. We are hero worshippers at the shrine of genius, and well pleased at the opportunity given to the world to express its admiration and appreciation before it has lost

> the touch of the vanished hand
> And the sound of the voice that is still.

It is only those who stand somewhat within the realms of science that can fully understand the true meaning of the length and breadth and mighty depth of Kelvin's labours. The workaday world sees a formula which guides the calculations of its engineers, but it has no conception of the labour involved in obtaining that formula, nor the money and time saving medium that formula really is. A sentence or a formula may embody the work of a lifetime, and confer benefits upon humanity out of all proportion to the honours which may be showered upon the discoverer. Thus it is in the case of Lord Kelvin. We know where we stood before he commenced his labours, and we know how simple some things are now which were then deemed impossible. We know the routine of the civilised world has been changed largely by his genius, and no honours conferred upon the man, or words of approbation, can adequately convey the world's appreciation of these facts. Glasgow has been unanimous in paying honour to her gifted citizen, and congratulatory telegrams and addresses have been sent from all quarters of the world, from the Queen and Prince of Wales downwards. Elsewhere we give two memoirs of our hero—one from the *Scotsman*, the other from the *Times*. Our readers are perhaps better able than the major portion of the non-scientific community to understand Lord Kelvin's unique position, not only among scientific men of this country, but in the whole world. In electrical matters he can hardly be said to have a rival, for not only as a theorist does he stand in the front rank, but by combining practical with theoretical work he has given to the world so many pieces of apparatus unrivalled of their kind that we can only stand and wonder. Fifty years ago—1846—what was the position of applied electricity then? Three years before—in 1843—a return was made to the House of Commons in connection with the Admiralty semaphore from London to Portsmouth. That was the system electric telegraphy was destined to replace. That semaphore cost from three thousand to three thousand five hundred pounds a year, and was worked five hours a day in winter and seven hours a day in summer, while on an average it could not be worked during one hundred and eight days in the year

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at all—at all. Shade of Monte Christo, where art thou? The sprig of 1843 is universal to-day. A year after Lord Kelvin—then Prof. W. Thomson—entered upon his duties, the length of telegraph lines in Great Britain only reached a thousand miles, a length reached in America the year of his election. Prof. Thomson must have been well acquainted with the birth of the telegraph, for he even then had devoted his attention to the study of electricity. But his special work in this direction came later on when men of enterprise entered into the question of connecting the Old and the New World by a submarine cable. Their trials, their failures, and their successes, are they not told in the annals of that time? And what a glorious part Prof. Thomson played in obtaining success. For this he received the honour of knighthood. We have no wish to trace the progress of applied electricity as Lord Kelvin has seen it, and in which he has ever held a foremost place. Then telegraphy was just making headway, cable work hardly dreamt of, electrolytic work on a large scale unknown; the dynamo—the creation of Faraday—existed more in the cruder forms of motors driven by batteries; electric light, electric transmission of power only daydreams; telephony lay in the dim and distant future. Now, on the day of his professorial jubilee, these are accomplished facts, so common that they have ceased to excite curiosity. The part played by Lord Kelvin in every new departure has been important. He made long-distance cables possible, he has given us instruments and apparatus of precision so admirable, in fact, that electrical measurements are probably far more exact than any other measurements of whatever kind. But there is another phase of his life's work that is more often than not completely forgotten. Directly and indirectly he has influenced the lives of hundreds of students. This influence is felt pulsating through all scientific circles from Japan on the one side, by Asia, Africa, and Europe to America on the other side. The inventor and the discoverer may only be put side by side with the teacher, the one genius embodying in the highest degree these three phases of interest to civilised humanity, any one of which would satisfy the ambition of an ordinary mortal and render him a hero to his fellows.

THE INSTITUTION AND LORD KELVIN.

As might have been expected, the Institution of Electrical Engineers has been among the most earnest and most sincere well-wishers of Lord Kelvin upon the occasion of his jubilee at Glasgow.

The President, Dr. J. Hopkinson, F.R.S., in presenting the address, said:

The Institution of Electrical Engineers acknowledge that you are in a very literal sense the father of their profession. You have done more, much more, than any other man in this or any land to place that profession in the honourable position it now occupies. The Institution have deputed me, their president, to hand you this address as a token of hearty love and esteem from your children.

The following is the address:

To the Right Honourable Lord Kelvin, D.C.L., LL.D., Past-President of the Royal Society.

We, the President, Council, and Members of the Institution of Electrical Engineers, desire hereby to offer to your lordship our sincere and hearty congratulations on the occasion of the jubilee of your professorship of Natural Science in the University of Glasgow.

It will ever be a source of pride and satisfaction to this Institution that one who occupies so pre-eminent a position in the scientific world should have been its first president in 1889, besides having been an original member and president in 1874 of the same association, when it existed under the name of the Society of Telegraph Engineers.

Not only have you contributed more than any other living man to our knowledge of the laws of nature, but you have found time to perfect practical applications of science wherefrom every branch of the electrical engineering profession has derived special benefit.

We desire, in conclusion, to express our fervent wish that you may continue for many years to enjoy the blessings of good health, and that science may still further benefit by your labours.

John Hopkinson, *President.*
F. H. Webb, *Secretary.*

LORD KELVIN'S JUBILEE.

The *Scotsman* of June 15 gives the following interesting details of Lord Kelvin's career:

In view of the jubilee a brief reference to some of the leading features of Lord Kelvin's life and work may not be without a special interest. Lord Kelvin is a scion of the Scoto-Irish race of Ulster—a race, by the way, wonderfully prolific in genius. He was born in College-square, Belfast, on June 25, 1824. His father, Dr. James Thomson, was at the time Professor of Mathematics in the Royal Academical Institute, Belfast, but in 1832 he received an appointment to the Chair of Mathematics in the Old College of Glasgow. At the early age of 11 the future Lord Kelvin became a student at Glasgow College—having up till that age been under the personal tuition of his father; and at college his marvellous rapidity in solving problems quickly made itself apparent. From Glasgow he passed to St. Peter's, Cambridge, where he graduated in 1845 as second wrangler and first Smith's prizeman, a university examiner remarking that although he had only taken second place, the first wrangler was "unworthy to cut Thomson's pencils for him." He was immediately elected a Fellow of his college. While at Cambridge he began at the age of 17 to contribute to the *Cambridge and Dublin Mathematical Journal*, and his writings speedily attracted the attention of savants. His earliest contributions to physical science were a defence of Fourier in answer to a charge of erroneousness which had been brought against some of the fundamental formulas of his harmonic analysis, and a paper on "The Uniform Motion of Heat in Homogeneous Solid Bodies, and its Connection with the Mathematical Theory of Electricity," the spirit of the latter running through much of Lord Kelvin's subsequent work. In this paper he pointed out the analogy between the theory of the conduction of heat in solid bodies and the theory of electric and magnetic attraction, and aiding himself with this analogy, made use of known theorems as to the conduction of heat in order to establish some of the most important theorems in the mathematical theory of electricity; and in conjunction with Faraday's researches on electrostatic induction it proved of the highest value in the discussion of questions in electrostatics and also in magnetism. A paper on "The Linear Motion of Heat" was another contribution to scientific literature made by him about the same time, and in which there was contained the foundation of the method of evaluating absolute geologic dates from underground temperature. This paper was delivered on the occasion of his being installed as professor at Glasgow University, and when he was in his twenty-second year. In this same year he became editor of the *Cambridge and Dublin Mathematical Journal*, also contributing papers to *Liouville's Journal de Mathematique*, one of his earliest papers on "Laws of Statical Electricity" having appeared in this publication while he was studying at Paris in the laboratory of the famous Regnault. Papers on electrostatics and magnetism appeared at frequent intervals from his pen. One of the most notable first appeared in the French journal already named. In it Thomson unfolded the

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principle of "electric images," by means of which he showed by simple geometrical principles the way to solve many problems of an apparently very complicated nature as to the distribution of electricity on a system of conductors under the influence of a given electrified system. His electrostatic researches led him to the invention of an instrument for electrostatic measurement, and his labours in this direction produced the quadrant electrometer which is employed for all kinds of electric testing in telegraph construction and for the registration of atmospheric electricity at Kew Observatory; a portable electrometer for atmospheric electricity and other purposes in which extreme sensitiveness of the quadrant electrometer is not required; and the absolute electrometer, which serves to reduce the scale readings of other instruments to absolute measure, and was used by Lord Kelvin in his measurement of the electrostatic forces producible by a Daniell's battery. In other directions he was at the same time making important investigations, as was shown by the series of papers on the "Dynamical Theory of Heat" which he communicated to the Royal Society of Edinburgh, and in which he placed the whole science of thermodynamics on a thoroughly scientific basis. Among the most important results of his investigations in this connection was his discovery of the principle of the dissipation of energy, which he announced in 1852. Three years later he made another important announcement in his discovery of the electric convection of heat, and also of a number of new relations between thermal and electric properties of matter. At different times there followed papers in which he calculated the size of atoms, and went the length of laying down an hypothesis regarding their formation. He has also published a memoir on the mechanical energies of the solar system, and on his determination regarding the rigidity of the earth, in addition to researches on the tides and on vortex motion. His address as president of the British Association at Edinburgh in 1871 was particularly notable from the fact that it was in his most popular style. In it he discussed the question, "How did life originate on the earth?" and his concluding sentence ran: "The hypothesis that life originated on this earth through moss-grown fragments from the ruins of another world may seem wild and visionary; all I maintain is that it is not unscientific." His later contributions have, for the most part, been a development of investigations previously entered upon.

While Lord Kelvin's scientific renown is regarded by savants as culminating over his experimental and mathematical researches in the various departments of natural philosophy, the public knows him chiefly through the inventions which he has made concurrently with his work in the application of mathematics to the solution of physical problems. To the public at large he first became known in connection with the laying of the Atlantic cable. Along with the late Mr. Cyrus Field he was the chief means of bridging the gulf of communication between Europe and America, and of accomplishing a feat greater than that of Puck, when this sprite boasted that he would put a girdle round the earth in 40 minutes. When the first cable was proposed the difficulty of the retardation of signals was still unsolved. The question therefore arose as to whether it would be possible to make communication between Europe and America pay, as the transmission of a signal took six seconds to pass across the Atlantic. His investigations led to a true understanding of the nature of the phenomenon of retardation and to the invention by himself of an instrument—the "mirror galvanometer"—which obviated the lagging of the electric currents, and enabled the communication to be registered without delay. In brief, he made submarine telegraphy as successful as land telegraphy. The original cable was laid in 1858, but within a fortnight it failed, and it was not until 1866 that the Old World and the New were finally and successfully coupled together. When he returned home, Mr. Thomson, as he then was, received the honour of knighthood. With the cable in working order, Sir William continued to devote his attention to this practical branch of electricity, and as the "mirror" instrument left no trace of the message transmitted, which had to be written down by the receiving clerk, this led to his invention of the "syphon recorder," by means of which a permanent record of all messages is secured, and it is now employed at almost all submarine stations. During many of his investigations in connection with submarine telegraphy, Sir William had the assistance of the late Mr. C. F. Varley, F.R.S., and the late Prof. Fleeming Jenkin. Sir John Pender was the first to adopt the "syphon recorder" in the year 1870. In conjunction with Prof. Jenkin, Sir William acted, between 1869 and 1875, as engineer for the French Atlantic cable, the Mackay-Bennet Atlantic cable, the Brazilian and River Plate and the West Indian cables.

In 1873, while on his way to South America in connection with the laying of the Brazilian and River Plate cables, Sir William made his first experiment with his now well-known apparatus for sounding the deep sea with a steel pianoforte wire instead of by the ordinary lead-line. This invention consists of a pressure gauge, which, thrown overboard at the end of a wire, accurately records the depth of water while the vessel is going at full speed. With the old lead-line soundings could only be taken once an hour, whereas with the new instrument it is possible to take a cast once every 10 minutes. But while he has invented many apparatus for assisting seamen in the navigation of their vessels, the most important is his mariner's compass. This invention came about in rather a curious manner. He had undertaken in 1874 to contribute a short series of articles to a popular magazine on the mariner's compass, but while gathering material for the papers he became alive to the faults of existing compasses, and between the publication of the first of the articles and the second there was a lapse of five years, Sir William in the meantime having invented a mariner's compass of exquisite construction, which enabled the errors arising from the magnetism of iron ships to be accurately corrected. The story is told that Sir William sent his compass to Sir George Airy at the Royal Observatory for his inspection, and that Sir George after examining it shook his head and ejaculated, "It won't do." When Sir William heard of this, he merely remarked "So much for the Astronomer Royal's opinion!" The Admiralty also rejected it, but to-day the maritime world is in agreement with the captain of the Cunard liner who not long ago said, "Lord Kelvin's sounding machine and compass have done more for the safety of navigation than any invention since the first compass and sextant. The cherub up aloft who watches over poor Jack always takes in my eye the shape of that clever and wise Scotsman who has given us the best chance of getting safe to port." Lord Kelvin's "Tables for Facilitating the Use of Sumner's Method of Ascertaining a Ship's Place at Sea" are regarded as of very high importance, and his machine for predicting the level of the tides in any part of the world is one of the most notable of his non-electrical inventions, which range down to the humble domestic water-tap. Of late years Lord Kelvin has also identified himself largely with the work of introducing the electric light both for public and domestic purposes.

In addition to valuable work on different Royal Commissions, Lord Kelvin is a voluminous author. Apart from his contributions to pure science and his writings on "Navigation," he is the author, in conjunction with Prof. Tait, of Edinburgh, on a treatise on natural philosophy, which is used as a class-book. His "Popular Lectures and Addresses," however, while affording a great intellectual treat, even require a vigorous mental digestion. He is, like his late brother, the coiner of a considerable number of scientific expressions. Among these are "mho," "motivity," "diffusivity," "infinitesimal satellites," and "irrotational circulation." The words of a recent writer in summing up Lord Kelvin's position in the scientific world may here be given: "In heat his name is coupled with those of Joule and Rankine; in the dynamical theory of gases with Clausius and Helmholtz; and in electricity and magnetism with Faraday and Maxwell. . . . Apparently his name will go down to posterity with those of Galileo, Newton, and Pascal. So far he is unique in science by reason of his multifarious and diversified career. His achievements would suffice to make at least three eminent reputations, for not only is he

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the greatest physicist of the day, but the leading electrical engineer and one of the most celebrated inventors. He is the Napoleon of science." That his merits have not gone unrecognised by the world may be seen from the honours heaped upon him. He is an LL.D. of Cambridge, Edinburgh, Dublin, and Montreal; a D.C.L. of Oxford; a past-president of the Royal Society of Edinburgh, a past-president of the British Association, a past-president of the Royal Society (having been the first Scottish professor to hold that office), a past-president of the Institute of Electrical Engineers, a foreign associate of the French Academy, a Grand Officer of the Legion of Honour of France, a Knight of the Order Pour le Merite of Germany, and a Commander of the Order of Leopold of Belgium. In addition to all these and other titles which he holds, he was made a peer of our own realm in 1892.

Lord Kelvin has been the recipient of many tokens of the esteem in which he is held by the citizens of Glasgow, his fellow professors, and also the students, who have been attracted to his classroom from every part of the world. He was entertained to dinner after each mark of Royal favour, and a few years ago he was publicly presented with his portrait. At the time of his election as president of the Royal Society the students at the University of Glasgow presented him with an address, in which they stated that he had "gained their warm esteem and unaffected admiration by his uniform courtesy and kindness, as well as by his rare gifts as a scientist and a scholar." It may be mentioned that in 1855, when Lord Kelvin was making his investigations into the question of the "electric convection of heat," he called in his students for the first time to aid him, and that from that time onward he has invited and received their co-operation in the university physical laboratory, now under the superintendence of himself and his gifted nephew and assistant, Dr. J. T. Bottomley, F.R.S. Lord Kelvin has all his life regarded athletic exercises and pastimes with favour, and this has added to his popularity among the students. While at Cambridge he frequently took part in university rowing competitions, and won the Silver Sculls. He was also president of the Cambridge University Musical Society. In the early days of the volunteers he was an enthusiastic soldier-citizen, and it was while curling that he received an injury—now fully 30 years ago—which left him permanently lame. For many years he also spent the summer vacation in his own yacht. In Lord Kelvin the students have found that the best teacher of a science, even of the elements of a science, is not the man of plodding and painstaking mediocrity, but the original thinker and investigator, who succeeds by his own enthusiasm for his subject in awakening in younger minds an interest and enthusiasm for it akin to his own. It need only be added that amidst all his accumulated honours Lord Kelvin is as simple, gentle, and unpretending as he is able and accomplished. The fact is so well known it is scarcely necessary to mention that he took a very active part in the agitation against Irish Home Rule, and that since 1886 he has supported the Unionist party, having previously been a follower of Mr. Gladstone. Lord Kelvin has been twice married. The present Lady Kelvin, whom he married in 1874, was a daughter of Mr. C. R. Blandy, of Madeira.

The *Times* has the following article on

The Electrical Inventions of Lord Kelvin.

It would be impossible to write the history of electrical discovery and invention in the last 50 years without reference to that immense share which Lord Kelvin has had in it. His contributions to it have not only been on the purely scientific side without equal, but, what is also remarkable, he has shown unusual power in bringing to bear abstract principles in the construction and invention of instruments having a most practical value. Broadly speaking, his practical electrical inventions fall into three great groups—first, those connected with telegraphy and submarine cables; second, those connected with navigation and the mariner's compass; and, thirdly, those connected with instruments of precision for electrical measurements. This by no means exhausts the series, but it is sufficiently distinctive.

The mathematical theory of the speed of telegraphic signalling through submarine cables was given by Lord Kelvin to the Royal Society in a paper communicated in 1855, entitled "The Theory of the Electric Telegraph." When the project of an Atlantic cable was first mooted Lord Kelvin established, in the face of some opposition, the true principles on which the speed of such signalling would depend, and in 1857 invented his celebrated mirror galvanometer, which was first used for sending signals through the short-lived 1858 Atlantic cable. In this instrument a very small magnetised fragment of a watch-spring has attached to it a tiny mirror, and the little magnet is suspended by a fibre of cocoon silk in the interior of a coil of wire. When the electric current is sent through the coil it causes a movement of the magnet, and this is indicated by the movement over a scale of the image of a spot of light reflected from the mirror. The telegraph clerks learn to interpret the erratic motions of this spot of light to and fro, and they are arranged to form a code of signals on the basis of the Morse alphabet. This simple device solved one of the problems in submarine telegraphy—viz., an instrument which would "receive" fast enough to render submarine telegraphy commercially possible. This was succeeded in the following years by the spark recorder, and finally by the syphon recorder, an instrument constructed to receive and record on a strip of paper the signals sent through long submarine cables. The first patent for this syphon recorder was obtained by Lord Kelvin in 1867, and the three succeeding years saw great improvements effected in it. This instrument is now the typical receiving instrument both for long and short submarine cables. These two instruments, first invented for cable work, have reappeared in various laboratory forms of late years. Every electrical laboratory has its mirror galvanometers and movable coil galvanometers, which, by whatever name they are called, are Lord Kelvin's invention.

An important invention in connection with submarine telegraphy was Lord Kelvin's automatic curb sender, an instrument devised to increase the rapidity of sending signals through submarine cables. By the use of a punched slip of paper like the card of a Jacquard loom, the rate at which signalling could be conducted was facilitated. It is impossible to omit in this connection mention of the valuable contributions of Lord Kelvin to the theory of cable-laying and to the various branches of the mechanics of submarine cable work. This, in conjunction with the mirror instrument, the syphon recorder, and the establishment of the true theory of electric signalling, laid the solid foundation on which commercial enterprise has established the vast industry of submarine telegraphic communication.

Then in respect of inventions connected with navigation Lord Kelvin's mind has been no less fertile. Bringing to bear the fullest scientific knowledge to the improvement of the mariner's compass, he has introduced into its construction the most valuable changes. He investigated with most complete care the causes of compass disturbance in iron ships and applied means to correct these disturbances. Although not strictly electrical inventions, it is hardly possible to refer to the compass without at the same time alluding to the improvements Lord Kelvin has effected in deep-sea sounding. By the ingenious use of pianoforte wire instead of rope, and a special depth indicator, he was able to effect soundings at great depths and even from a ship in motion. He has brought to bear the most exquisite mathematical skill in the construction of instruments for predicting the rise and fall of the tide in any place, based on a knowledge of one year's actual record as taken with an automatic instrument, and he has thus provided the navigator with improved instruments for his craft in three of the principal departments of his work. Lord Kelvin, be it remarked, is a practical navigator himself, and his yacht "Lalla Rookh" had been the scene of much experimenting before the above navigational inventions were perfected.

Turning, then, next to his inventions in electrical measuring instruments, it is not too much to say that he

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has revolutionised every department of them. In 1857 Lord Kelvin first described the instrument which afterwards developed into his quadrant electrometer and finally into the portable and absolute electrometers. These first instruments were developed in the course of his early studies in atmospheric electricity, in the progress of which he perfected every instrument required for that branch of observation. Electroscopes or electrometers, prior to the invention of the forms devised by Lord Kelvin, could hardly be classed as instruments of precision, but when he had completed their reconstruction they became invaluable as instruments of exact research. In later years Lord Kelvin has devised his electric balances for weighing electric currents, electrostatic voltmeters for measuring electrical potential difference or pressure, electric watt-meters for measuring electric power, and electric erg-meters for measuring electric energy. These instruments are found in every laboratory, electrical workshop, and electric station. In each and every one of these instruments is to be discovered some mechanical or electrical principle admirably applied. No measurements in the whole region of physics can now be made with greater accuracy and over greater ranges than those in electricity, and in every department of electrical measurement Lord Kelvin has contributed some invaluable apparatus or method. We find also rheostats, condensers, bridges, and numerous details of electrical apparatus stamped with the impress of his originality. It is hardly exaggeration to say that if we could take out from our knowledge of electrical measuring instruments all that Lord Kelvin has contributed in the way of practical invention the remainder would be exceedingly small. It is difficult to draw a sharply-marked line between Lord Kelvin's contributions to electrical theory and practice. His collected mathematical and physical papers, as well as popular lectures and addresses, show how closely the two are connected in his work. His theoretical contributions to electricity began in 1842 in a paper on "The Mathematical Theory of Electricity," and have continued in an unceasing stream ever since. His great papers in 1856 on "The Electrodynamic Qualities of Metals," on "Thermoelectric Phenomena," on "Effects of Stress and Strain on the Electric Qualities of Metals," all mark epochs in the history of the science.

In the preface to his great treatise on "Electricity and Magnetism," the late Prof. Clerk Maxwell remarks that when he first began to study electrical physics he resolved to read no mathematics on the subject until he had first read through Faraday's "Experimental Researches on Electricity"; and he states his indebtedness to Lord Kelvin for having first directed his attention to the fact that Faraday's method of viewing electrical phenomena was different from that of most other mathematical physicists. When we remember the supremely important consequences which have followed from Maxwell's study of the work of Faraday, it may well be questioned whether any service which Lord Kelvin has rendered to electrical science has a higher value than that which he rendered in directing the mathematical genius of Maxwell to a contemplation of the experimental work of Faraday. But Lord Kelvin has united in himself a large share of the experimental skill of the one as well as the mathematical ability of the other. He has, indeed, a larger reach in many respects than either, for to the precision and definiteness of aim given by the power to wield mathematical weapons with enormous effect he unites an almost inexhaustible ingenuity in experimental skill, enabling him to realise abstract conclusions in practical appliances, and whether he is considering the harmonic analysis of a tidal curve, a vortex theory of matter, an electrical theorem, or a proposition on crystallography, he finds his goal in a machine or an instrument which embodies in a concrete form his theoretical deductions. It is this combination of qualities which has made him so effective as a scientific worker and given to his achievements such an eminent vitality and power to stimulate other minds. He has in all aspects of his work a definiteness of purpose which brings him at once to the boundary from which he takes a fresh departure into the unknown, and to which he has but rarely returned without the spoils of victory in the form of some new practical invention or suggestive theory.

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

The subject of alternating currents, at one time considered to be one of the most abstruse in the domain of electrical engineering, has recently been brought within the mental reach of many students to whom formerly the task of grappling with it appeared quite hopeless. This is mainly due to the development of special elementary methods for dealing with alternate-current problems, for the introduction of which we are indebted to Blakesley, Kapp, Ferraris, and others. In this we have merely one illustration of the fact that the clearer the insight we gain into natural phenomena, the easier does it become to interpret them by the aid of methods which do not make too large a demand on the mental powers of those whose previous training is somewhat inadequate.

In what follows it will be supposed that the student is familiar with a little elementary algebra, and that he has mastered the fundamental principles of continuous-current phenomena. A knowledge of the C.G.S. electromagnetic system of units and their connection with the practical units will be assumed. If the student has studied trigonometry, so much the better. But for the sake of those whose mathematical studies have not extended beyond algebra the little trigonometry that will be required in what follows will be briefly explained. Should the explanations given be found too brief, the student is advised to refer to one of the many elementary text-books on the subject.

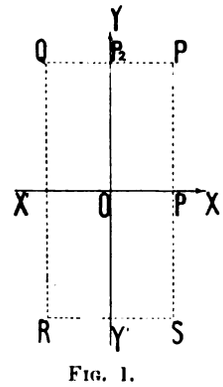

FIG. 1.

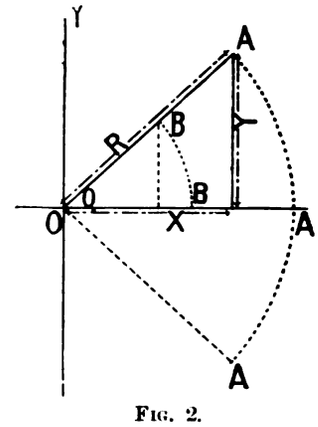

FIG. 2.

1. Take two straight lines, X′ X and Y′ Y (Fig. 1), intersecting each other at right angles in the point O. The position of any point P in the plane of the paper may be specified by assigning its perpendicular distances P P_1 and P P_2 from the two lines X′ X and Y′ Y respectively. The two reference lines X′ X and Y′ Y are termed the two *co-ordinate axes*. Their point of intersection O is called the *origin*. The distance P_2 P (= O P_1) of P from the vertical axis is called the *abscissa* of P, and its distance P_1 P (= O P_2) from the horizontal axis is called the *ordinate* of P. The abscissa and ordinate of P are sometimes spoken of as the *co-ordinates* of the point P. If x and y stand for the abscissa and ordinate of P respectively, the point P is denoted by enclosing its co-ordinates in brackets, thus: (x, y).

Let P Q R S be a rectangle, such that P_1 S = P_1 P, and P_2 Q = P_2 P. Then it is obvious that the co-ordinates of all the four points P, Q, R, and S have the same *numerical* values. In order to avoid ambiguity, we agree to regard distances measured to the right of the axis Y′ Y as positive, those measured to the left as negative; distances measured above X′ X as positive, below X′ X as negative. Hence, if x and y denote the *numerical* values of O P_1 and O P_2 respectively, the four points P, Q, R, S taken in succession are denoted thus:

$$(x, y);\ (-x, y);\ (-x, -y);\ (x, -y),$$

and there is now no ambiguity. The positive direction of

* Based on a series of evening lectures delivered at the University College, Liverpool.

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the horizontal axis is thus from left to right, and the positive direction of the vertical axis from below upwards, as indicated by the arrow heads in Fig. 1.

The problem of finding the position of a point P whose co-ordinates x and y are given presents no difficulty. We have merely to lay off from O a distance $O P_1 = x$ along the horizontal axis, and a distance $O P_2 = y$ along the vertical axis. Through the two points P_1 and P_2 we draw two lines parallel to the two axes respectively, and their intersection determines the point required.

2. Let a straight line O A (Fig. 2) be made to turn round one of its extremities, O, in a *counter-clockwise* direction until it comes into the position O A′. The angle $A O A' = \theta$ which the line has swept out is reckoned *positive*. If the line had swept out an equal angle A O A″ by turning in a *clockwise* direction round O, the angle would have been reckoned *negative*. Angles are commonly measured in degrees, minutes, and seconds. But for mathematical purposes it is much more convenient to adopt another method of measurement, which is as follows: Measure the length of the arc A A′, and divide it by the length of the radius O A; the quotient gives the *circular* or *radian* measure of the angle A O A′. It is obviously immaterial what radius we choose; for by taking a shorter radius, such as O B, we merely alter the scale of our diagram, but do not change the ratio of the arc (B B′) to the radius (O B). If the ratio of the arc to the radius is unity, we have a unit angle, or *radian*. Since the length of the circumference of a circle of radius r is $2\pi r$, the radian measure of four right angles is 2π; of two right angles, π; of one right angle, $\frac{\pi}{2}$; and so on.

Let in Fig. 2 O be taken as origin, and O A as one of the co-ordinate axes. Through O draw the other co-ordinate axis O Y. Let the length of the revolving line O A′ be r, let θ stand for the angle A O A′, and let x, y denote the co-ordinates of the point A′. Then

$\frac{x}{r}$ is called the cosine of θ, and is denoted by $\cos\theta$;

$\frac{y}{r}$ is called the sine of θ, and is denoted by $\sin\theta$;

$\frac{y}{x}$ is called the tangent of θ, and is denoted by $\tan\theta$.

These ratios are called *trigonometrical* or *circular functions* of the angle θ.

An inspection of Fig. 2 will easily convince the student of the truth of the following statements:

The cosine and sine of an angle are capable of assuming any values between -1 and $+1$.

The tangent of an angle may have any positive or negative value, however great numerically. As the angle approaches a right angle $\left(\frac{\pi}{2}\text{ in radian measure}\right)$, its tangent increases indefinitely.

It is hardly necessary to draw the student's attention to the fact that a change in the length of the line O A′ ($=r$) will merely alter the scale of our diagram, and will not affect the values of the ratios $\frac{x}{r}$, $\frac{y}{r}$, and $\frac{y}{x}$.

3. When two quantities are so related that the value of one of them is dependent on that of the other, we say that the first quantity is a *function* of the second. Thus, if we consider the current in a circuit of given resistance, we know that the current will depend on the E.M.F. We may therefore say that the current is a function of the E.M.F. Again, taking the E.M.F. of a given dynamo running at a certain speed with a given external resistance, we may say that the E.M.F. of the dynamo is a function of the speed (*i.e.*, it is dependent on, or determined by, the speed). Corresponding to any value of one of the quantities considered, we have a certain value of the other quantity. This at once suggests a method of graphically representing the connection between the two quantities, for we have merely to regard the values of one of the quantities as the abscissæ of certain points whose ordinates are the corresponding values of the other quantity or function. Such a series of points will lie on a certain curve, and the curve shows us at a glance how the two quantities are related. Such a curve is termed the *graph* of the corresponding function.

4. In most of the cases which will claim our attention we shall have to deal with quantities whose values are constantly varying as time goes on, so that their values will depend on the particular instant of time at which we consider them; in other words, we shall have to deal with quantities which are *functions of the time*. The variation of such functions is conveniently represented, as explained in the preceding section, on a sheet of squared paper, by plotting the values of the time as abscissæ, and the corresponding values of the function as ordinates. Fig. 3 is an example of how this may be done, and exhibits the changes in the E.M.F. of a certain alternator during ·004 of a second.

Most of the time-functions with which we shall have to deal exhibit a certain peculiarity—viz., they run through a certain cycle of values which is repeated time after time. Such functions are termed *periodic* time-functions. The time taken by the function to go through the complete cycle of values to which it is restricted is called the *periodic time*, or simply the *period*, of the function. If, then, we choose any one value which the function is capable of assuming, this value will be repeated at equal intervals of time, each interval being equal to the period of the function.

5. Let us consider any function of the time, and study the manner in which the function changes as time goes on. In the case of some functions we may find that equal changes in the function take place in equal intervals of time. When this is the case, the function is said to change at a *constant rate*, and we define the *rate of change* of the function as the *change which it undergoes in unit time*. In

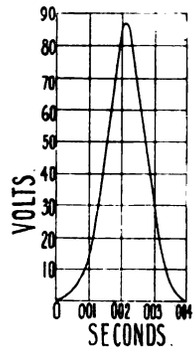

FIG. 3.

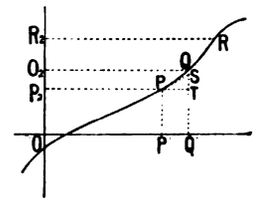

FIG. 4.

the case of most functions with which we shall have to deal, however, the changes which take place in the value of the function during equal intervals of time are unequal. In such a case we say that the rate of change of the function is variable, and we define as the *average rate of change* of the function *during any interval of time* the change which takes place in the function, divided by the time during which that change has taken place.

Let P Q R (Fig. 4) represent the graph of a time-function, and let us suppose that as the function changes its graph is recorded by a tracing point. When the point arrives at the position P, it is moving along the tangent to the curve at that point. Let us suppose that during the next unit of time the tracing point *goes on* moving along the tangent instead of following the graph along the curve P Q. If $P_1 Q_1$ represent a unit of time, the point will arrive at the position S at the end of the unit of time. Through P draw a line P T parallel to the axis of time. Then the change in the value of the function which would have taken place in a unit of time had the tracing point followed the tangent at P is represented by T S; we define T S as the *instantaneous rate of change* of the function at P, or its rate of change at the instant when its value is $P_1 P_2$. Now, T S is the distance through which the tracing point would have moved *in a vertical direction* had it followed the tangent at P—*i.e.*, T S is the vertical velocity of the tracing point when in the position P. We thus arrive at the result that the instantaneous rate of change of a function is given by the vertical velocity of the point which traces out its graph.

6. The *orthogonal projection* of any point P (Fig. 5) on a straight line A B is defined as the foot P_1 of the perpen-

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dicular P P_1 drawn from P to A B. The orthogonal projection of any curve P Q R on the straight line A B is obtained by dropping perpendiculars P P_1 and R R_1 from its two extremities P and R on the straight line; $P_1 R_1$ is defined as the orthogonal projection of P Q R on A B. Instead of saying "orthogonal projection," we shall in future use the term "projection" simply. It will be seen that the projection of any curve on the straight line A B merely depends on the position of the extremities of the curve, and is quite independent of its shape. Thus, in Fig. 5, the projection of the curve P Q R is precisely the same as the projection of the straight line P R joining the extremities of the curve.

Through P draw P S parallel to A B. Then P S = $P_1 R_1$ = projection of straight line P R on A B. Also, by definition (Art. 2), $\frac{PS}{PR} = \cos S P R$, so that $P_1 R_1 = PS = PR \cos S P R$. We thus have the following proposition: *the projection of any given straight line on another straight line is equal to the length of that line, multiplied by the cosine of its angle of inclination.* By the "angle of inclination" is meant the angle between the two lines.

7. Returning now to the graph of the function shown in Fig. 4, let us consider the projection on the vertical axis of the point which traces out the graph. As this point passes through the positions P, Q, R, its projection on the vertical axis passes through the positions P_2, Q_2, R_2 respectively. From the explanation regarding the rate of change of a function given in Article 5, it will now be evident that this rate of change is given by the *velocity with which the projection of the tracing point moves along the vertical axis.* This result, which is of great importance, we shall have occasion to use later on.

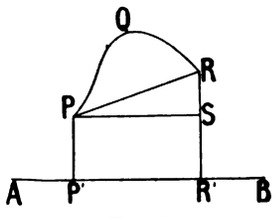

Fig. 5

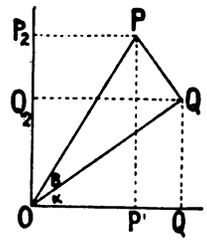

Fig. 6.

8. There are certain relations connecting the sine, cosine, and tangent of a given angle which will be required in what follows, and which we shall now briefly establish. Returning to Fig. 2, we see from its geometry that

$$x^2 + y^2 = r^2,$$

whence
$$\left(\frac{x}{r}\right)^2 + \left(\frac{y}{r}\right)^2 = 1,$$

or
$$\cos^2\theta + \sin^2\theta = 1 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $\cos^2\theta$ stands for "the square of the cosine of θ," with a similar notation for the sine of θ.

Next,
$$\frac{x}{r} \Big/ \frac{y}{r} = \frac{x}{y},$$

or,
$$\frac{\sin\theta}{\cos\theta} = \tan\theta \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Again, by referring to Fig. 2 and remembering the convention regarding signs (Art. 1), the student will readily see that the following relations hold:

$$\cos(-\theta) = \cos\theta \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$\sin(-\theta) = -\sin\theta \quad . \quad . \quad . \quad . \quad (4)$$

Next, from Fig. 2 we see that $\frac{x}{r} = \sin\left(\frac{\pi}{2} - \theta\right)$, so that

$$\cos\theta = \sin\left(\frac{\pi}{2} - \theta\right) \quad . \quad . \quad . \quad . \quad (5)$$

Similarly,
$$\sin\theta = \cos\left(\frac{\pi}{2} - \theta\right) \quad . \quad . \quad . \quad . \quad (6)$$

We have finally to establish some formulæ regarding the sine and cosine of the sum and difference of two angles. This is most readily done by making use of the results established in Art. 6 regarding orthogonal projection. Let, in Fig. 6, P Q be drawn perpendicular to O Q, while P P_1, Q Q_1 are both perpendicular to the horizontal axis, and P P_2, Q Q_2 perpendicular to the vertical axis. Projecting first on the horizontal axis, we have

projection of O Q = projection of O P + projection of P Q—*i.e.*, bearing in mind (5) and (6),

$$O Q \cos\alpha = O P \cos(\alpha + \beta) + P Q \sin\alpha.$$

Now, since O Q = projection of O P on O Q = O P $\cos\beta$,

and P Q = projection of P O on P Q = P O $\sin\beta$,

the above equation becomes

$$O P \cos\alpha \cos\beta = O P \cos(\alpha+\beta) + O P \sin\alpha \sin\beta,$$

or,
$$\cos(\alpha+\beta) = \cos\alpha\cos\beta - \sin\alpha\sin\beta \quad . \quad . \quad (7)$$

In like manner, by projecting on the vertical axis, we establish the equation

$$\sin(\alpha+\beta) = \sin\alpha\cos\beta + \cos\alpha\sin\beta \quad . \quad . \quad (8)$$

Using now equations (3) and (4), and putting $-\beta$ for β in (7) and (8), we obtain

$$\cos(\alpha-\beta) = \cos\alpha\cos\beta + \sin\alpha\sin\beta \quad . \quad . \quad (9)$$

$$\sin(\alpha-\beta) = \sin\alpha\cos\beta - \cos\alpha\sin\beta \quad . \quad . \quad (10)$$

All the formulæ given above are of very great importance, and the student is advised to thoroughly master them before going any further.

(To be continued.)

ELECTRIC AND MAGNETIC RESEARCH AT LOW TEMPERATURES.*

BY J. A. FLEMING, M.A., D.SC., F.R.S., M.R.I.

(Continued from page 663.)

Having thus defined our scale of temperature we proceeded to embody the whole of our results in a chart, which is now before you (see Fig. 6), and on which vertical distances represent resistivity, or specific resistance, or the resistance in absolute measure per cubic centimetre of the various metals, and horizontal distances represent platinum temperatures. The

Electrical Resistivity of Pure Metals Annealed.

Metal.	Resistivity in C.G.S. units at 0deg. C.	Percentage increment, 0deg. to 100deg. C.	Atomic volume.
Silver	1,468	40·0	10·04
Copper	1,561	42·8	7·10
Gold	2,197	37·7	10·04
Aluminium	2 665	43·5	10·56
Magnesium	4,355	38·1	13·76
Zinc	5,751	40 6	9·12
Iron	9,065	62 5	7 10
Cadmium	10,023	41·9	12 96
Palladium	10 219	35·4	9·12
Platinum	10 917	36 69	9·12
Nickel	12,323	62·2	6·94
Tin	13,048	44 0	16 20
Thallium	17,633	39·8	17·20
Lead	20,380	41·1	18 27
Mercury	94,070	—	—
Bismuth	108,000	—	—

Electrical Resistivity of Alloys.

Alloy.	Composition.	Resistivity in C.G.S. units at 0deg. C.	Percentage increment, 0deg. C. to 100deg C.
Aluminium copper	94 : 6	2,904	38·1
Aluminium-titanium	—	3,887	29·0
Aluminium-silver	94 : 6	4 641	23·8
Gold-silver	90 : 10	6,280	12·4
Copper-aluminium	97 : 3	8,847	8·97
Copper-nickel-aluminium	87 : 6½ : 6½	14,912	6 45
Platinum-rhodium	90 : 10	21,142	14·3
Nickel-iron	95 : 5	29 452	20·1
German silver	$Cu_2Zn_2Ni_2$	29,982	2 73
Platinum-iridium	Pt_4Ir	30,896	8·22
Platinum-silver	1 : 2 $PtAg_4$	31,582	2 43
Platinoid	—	41,731	3·1
Manganin	—	46,678	0
Iron-manganese	88 : 12	67,148	12·7

* A Friday evening discourse delivered at the Royal Institution, June 5, 1896. Lord Kelvin in the chair.

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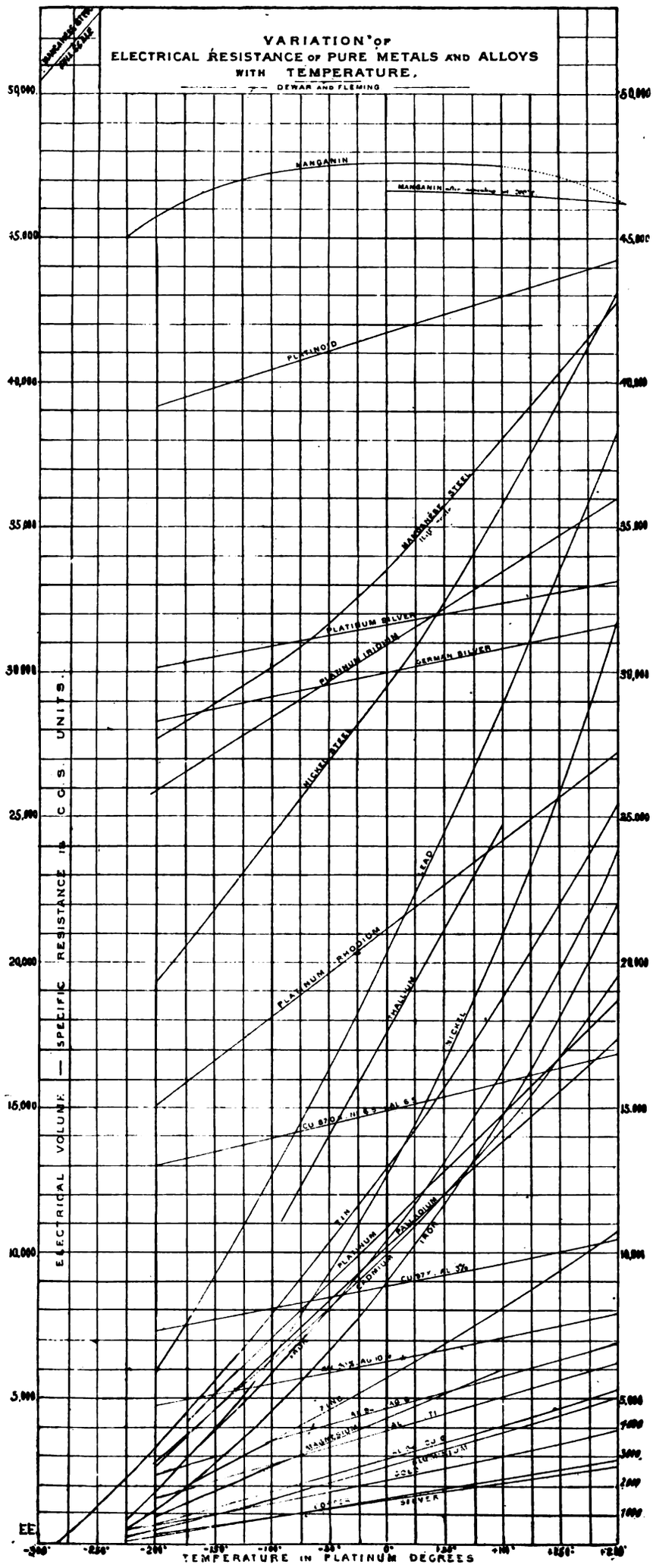

FIG. 6.

curves indicate the manner in which the specific resistance varies with temperature for each substance. The first thing which strikes us on looking at the chart is that the lines for the pure metals all converge downwards in such a manner as to indicate that their electrical resistance would vanish at the absolute zero of temperature, but that no such convergence is indicated in the case of alloys. We have found that the slightest impurity in a metal changes the position of this resistance line. In the next place, note that the order of conductivity is different at low temperatures to that at ordinary temperatures. At 0deg. C. pure silver is the best conductor, but at −200deg. pure copper is better than silver, and the position of mercury is, of course, very different. Again, the lines of some metals are very much curved. The principal magnetic metals, iron and nickel, have lines which are very concave upwards, and this is a characteristic apparently of many magnetic alloys. The mean temperature coefficient of these magnetic metals between 0deg. C. and 100deg. C. is much larger than that of other metals, and the percentage decrease in resistance in cooling them from +200deg. C. to −200deg. C. is greater than in the case of any other metals. The tables before you show the values of the resistivity of pure metal and alloys as found by us (see tables).

It is worth noting, in passing, that these magnetic metals, iron and nickel, have smaller atomic volumes than any other metal, and that, generally speaking, the worst conductors amongst the metals are those that have the large atomic volumes and large valency. Next, turning to alloys, we may make mention of a few general facts with regard to their resistance. If to one pure metal we add a small quantity of any other metal, the result is always to raise the resistance line almost parallel to that of the predominant constituent. Thus, in our chart, the alloy consisting of 6 per cent. of copper with 94 per cent. of aluminium is parallel to the aluminium line but higher up. Three per cent. of aluminium added to 97 per cent. of copper yields an alloy with a resistance line parallel to that of copper, also higher up. When two pure metals are alloyed together in various proportions there is generally some proportion in which the resultant alloy has a maximum resistivity, and except in the case of alloys of zinc, tin, lead, and cadmium with each other the resistivity of the alloy is greater than that of either of its constituent metals. In the case of many well-known alloys the proportions which give high, if not the highest, resistivity are those which correspond to definite and possible chemical combinations of the metals with each other—as, for instance, in the well-known platinum-silver alloy in proportions 33 to 66, which corresponds in proportion with the combination $PtAg_4$; the iron-nickel alloy in proportion of 80 to 20, which corresponds with the combination $NiFe_4$; the platinum-iridium alloy 80 to 20, which corresponds with the combination $IrPt_4$; and the copper-manganese alloy 70 to 30, which corresponds with the compound Cu_2Mn—all of which are, as far as valency is concerned, possible compounds. It is, however, found that very high resistivity generally involves in alloys a want of tenacity and ductility, and when we reach such limits as 100 microhms per cubic centimetre we begin to find the solid alloys becoming less useful on account of this deterioration of their useful mechanical quality.

We have especially studied the electrical resistance at low temperature of a large series of steel alloys containing vary-

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ing proportions of nickel, aluminium, chromium, tungsten, and manganese in them. The diagram (see Fig. 7) shows the results of these resistance measurements over a range of temperature from – 200deg. to + 100deg. In this diagram the resistance line of pure iron is also drawn, and we see that the effect of adding the other elements of the alloy is always to shift up the resistance line nearly parallel to itself so that the resistance lines of all the iron alloys are nearly parallel to that of the iron line, only the absolute value of all the ordinates is increased. This is equivalent to saying that the effect of the added material is to increase the specific resistance, but not to alter the slope or form of the resistance curve. Amongst these steel alloys there are two or three that are very interesting. A nickel-steel alloy sent to us by Mr. Hadfield containing 19 per cent. of nickel exhibits some very extraordinary properties. Nickel-steel alloys with large percentages of nickel can, as Dr. Hopkinson has shown,* exist over wide limits of temperature in two different physical states, in one of which they are strongly magnetic, and in the other of which they are feebly magnetic; and they pass from the non-magnetic to the feebly magnetic on cooling to low temperatures. Here, for instance, is a sample of the 19 per cent. nickel steel in the non-magnetic condition. If it is cooled in liquid air, we can make it pass instantly into a magnetic condition. In the first state it is fairly ductile and plastic, but in the second state it is very hard and brittle. Moreover, its electrical resistance is permanently altered on undergoing this change. In the non-magnetic state it has a high resistivity of about 81,500 C.G.S. units per cubic centimetre at 0deg. C., but on cooling in liquid air and becoming magnetic it is found to have decreased to about 47,200 C.G.S. units when taken at 0deg. C. It is perhaps more correct to say that this alloy can exist in an infinity of different physical states, because we have found that the lower it is cooled in temperature the lower its resistivity can be made to be when measured again at ordinary temperatures. On heating up the alloy again to a bright red heat, it goes back into the non-magnetic ductile state.

(To be continued.)

THE PHYSICAL SOCIETY.

At the meeting of June 12, Captain Abney, president, in the chair,

Mr. Campbell read a paper **"On the Measurement of Very Large and of Very Small Alternating Currents."** The author advocated the use of air-core transformers for measuring voltages and currents which are neither above or below the range of the instruments available. If an attempt is made to measure the current in the primary of an air-core transformer by observing the voltage on an open-circuit secondary, it is found that the readings depend on the frequency. In order to overcome this difficulty, the author uses a closed secondary with a very high inductance. In this case the primary current is proportional to the secondary current, which latter may be measured by an ammeter. The author has also investigated the case of transformers with iron cores, and of which the inductance of the secondary is large. In the case of a ring transformer with a closed magnetic circuit, if the load on the secondary consists solely of a Kelvin 100-ampere balance of very low resistance, the ratio between the primary and secondary currents is practically constant. With an open magnetic circuit transformer, however, this is not found to be so, as the ratio between the primary and secondary currents varies considerably with the frequency.

Mr. Blakesley said that the author's arrangement could only be used for measuring the current in the primary.

Mr. Griffiths exhibited and described his improved form of resistance box. This has many novel features: (1) It permits of all the coils being compared with one another without the use of standard coils, and with great ease and rapidity;

* See *Proc.*, Roy. Soc., 1890, vol. 47, p. 138.

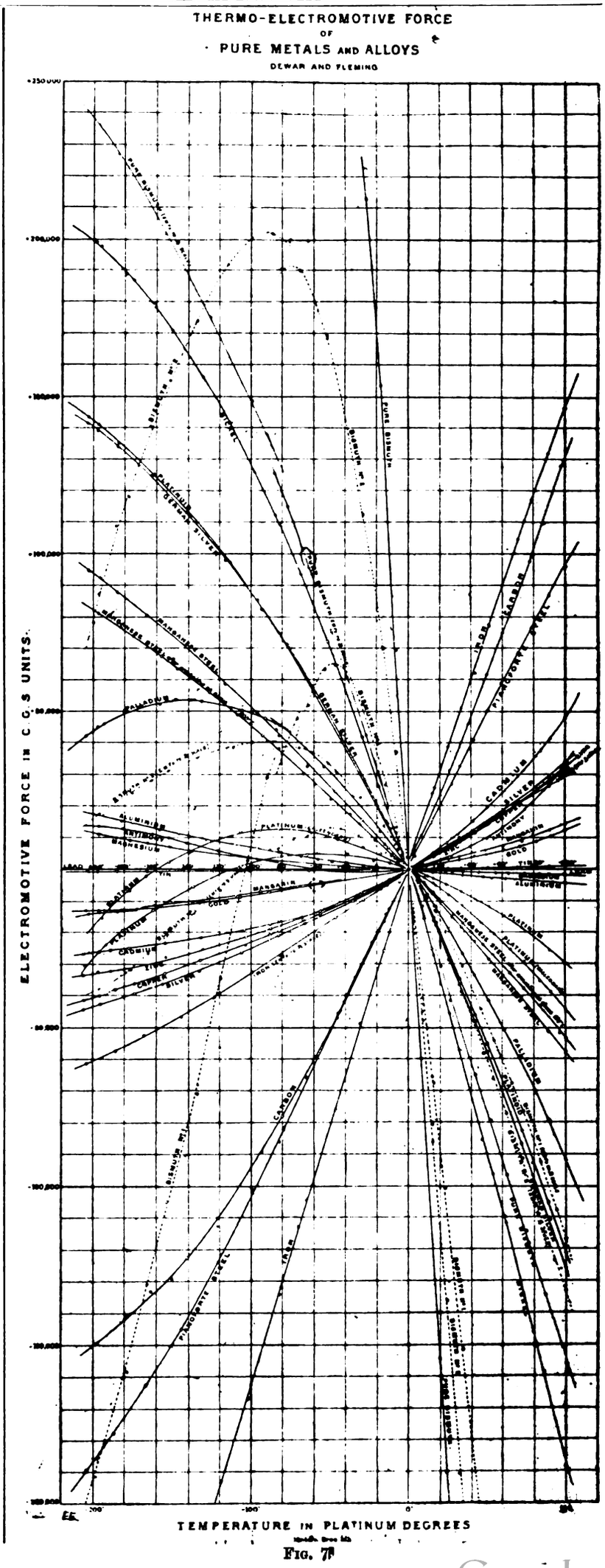

FIG. 7.

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hence, it is sufficient at any time to compare any one of the coils with a standard to obtain the correction to be applied to all the coils. (2) The bridge wire can be calibrated by means of the box itself. (3) The temperature of the coils can be accurately determined, since they consist of bare platinum silver wire wound on mica and immersed in an oil bath, which bath is kept stirred. (4) The resistance of the leads from the box to the object being tested is eliminated, as well as any error due to a change in this resistance with temperature. (5) The coils are arranged according to a binary scale, and the author claims that it is possible to measure resistances up to 105 ohms to within 0·000001 ohm. (6) All the coils, after being adjusted, have been heated to redness and allowed to cool slowly, so that all strain has been removed from the wire. (7) By having a separate pair of blocks for each plug it is impossible for the insertion of one plug to affect the fit of a neighbouring plug; the plugs themselves are so made that no part of the plug is wider than the top of the hole, and so it is impossible to wear a "shoulder" on the plug.

Prof. A. Gray said that Mr. Griffiths had discovered and remedied all the weak points of the ordinary form of bridge. Lord Kelvin had ordered the paraffin to be melted off the coils of one of his resistance boxes, and it was found that the resistance of the coils altered considerably, owing, no doubt, to the strain to which the wire was subjected when embedded in the solid paraffin. Lord Kelvin had made coils without paraffin, and was specially in favour of the use of the binary scale.

Prof S. P. Thompson said he considered the binary scale the weak point of the author's arrangement, since it did not permit of ratios other than 1 to 1 being employed.

Mr. Campbell asked what current could safely be passed through the coils.

The **Author**, in his reply, said that he believed it to be a great mistake to employ any ratio for the arms other than 1 to 1.

Prof. S P. Thompson read a communication on "**Rontgen Rays**" After describing the various forms of tubes he had made with a view of discovering the best form for the production of Röntgen rays, Prof. Thompson gave an account of the experiments he had made to try and obtain some indication of polarisation. In this connection a large number of crystals have been tested, but the experiments have all given negative results. The author exhibited an electroscope with aluminium leaves, and enclosed in a wire gauze screen to protect it from the influence of outside charges, by means of which he was able to show the discharge of a positively or negatively electrified body by means of the Röntgen rays. A method of obtaining dust figures by the discharge of an electrified body by the Röntgen rays was shown, and some of the results which have been obtained were exhibited. All attempts to obtain true reflection have failed, although it appears as if most bodies, including air, are capable of giving diffuse reflection.

Dr. Shettle, who was announced to give a paper on "**Rontgen Rays,**" explained that he had just discovered that the effects he had intended to describe were due to red light, which had penetrated his dark-room.

Prof. du Bois said that Galitzin had found that Röntgen rays were polarised by tourmaline, a special form of intensifier being necessary to bring out the result in the negative. The behaviour of tourmaline to light waves presented some curious features, for if the wave-length is increased a point is at length reached where the ordinary and extraordinary rays are equally absorbed. For greater wave-lengths the ordinary conditions are reversed. If the Röntgen rays were not homogeneous, the contradictory results obtained by different observers might be due to the fact that they were working with rays which were differently absorbed by tourmaline.

Mr. Swinton said he had tried the effect of heating the cathode and had obtained results which were similar to those obtained by the author. Mr. Swinton further said that he had found that the blue luminescence sometimes observed depended on the size of the cathode. With tubes in which the cathode was almost a complete hemisphere it was impossible to eliminate this blue luminescence.

Mr. Appleyard suggested the performance of the experiments under the surface of a dielectric.

Prof. Gray said he had obtained some indication of regular reflection, but nothing definite.

The **Author**, in his reply, said that it had been found that if the Röntgen rays are reflected from a surface of sodium *in vacuo*, the amount reflected is a minimum for normal incidence and increases at oblique incidence. Comparing this behaviour with that of ultra-violet light, it supports the idea that the Röntgen rays consist of transverse vibrations.

The society then adjourned till June 26.

COMPANIES' MEETINGS AND REPORTS.

WEST AFRICAN TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held last week at the offices, Winchester House, E C., Sir Henry C. Mance, C.I.E., M.I.C.E, presiding.

The **Chairman**, in moving the adoption of the report, said on the last occasion of their meeting their chairman (Sir John Pender) was absent on important business in connection with the general election then going on, and that day, he was sorry to say, Sir John was absent through serious illness. With regard to their work of the year, the gross revenue amounted to £74,333, against £64,761 in 1894, being an increase of £9,572. The total working expenses for 1895 amounted to £17,424, against £17,286; so that, notwithstanding the greater volume of traffic to be dealt with, the efficiency of the system had been fully maintained without any material increase in the expenditure. The loss on exchange was about the same as in the previous year, representing nearly 2½ per cent. on the total share capital of the Company. The directors, taking into consideration the large amount they had been obliged to take from the reserve fund in the past for repairs, especially in 1893, considered it advisable to carry £15,000 to the general reserve fund. They were able to recommend a final dividend of 3 per cent., making, with the interim dividend already paid, a total distribution of 4 per cent. for the year, and carrying £1,760 forward to the next year's account. The reserve fund would now amount to £48,350, and it would be seen that the Company had over £43,000 actually invested at the present moment in first-class securities.

The report was carried unanimously.

CONTINENTAL METROPOLITAN TRAMWAYS COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Wednesday at the Cannon-street Hotel, Mr. B. H. Van Tromp in the chair, to consider a resolution approving a provisional agreement between the Company and the Compagnie Française pour l'Exploitation des Procédés Thomson-Houston, dated the 15th inst., and empowering the directors "to do all things needful for carrying the same into effect."

The **Chairman,** in moving the adoption of the resolution to this effect, said that the Thomson-Houston Company, which was an offshoot of a large and important general electric company in New York, had established themselves in France as a French company, and had purchased the tramways at Havre and Rouen, which they had converted into electrical tramways. They greatly desired to begin operations by a grand movement in Paris, and the subject was mentioned casually to one of their directors about six weeks ago. On the 17th ult., however, they received a letter from this French company, dated from Paris, in which they made an offer of £320,000 for this Company's undertaking, the French company to take the profits as from December 31 last. After discussing the offer it was declined, and he stated to two representatives of the Thomson-Houston Company that what they wanted for the undertaking was in round figures about £400,000. On the 20th ult. the directors received a letter in which £358,000 was offered for the undertaking. This proposal was discussed by the directors, and he telegraphed to Paris that the lowest sum they could advise the shareholders to take was £392 800 and the profits for the six months up to the 30th inst., and the French company must take over the bonds or obligations entered into in Paris, under which this Company had to pay back £10,000 a year until the discharge of the bonds in question, on which £100,000 was still due The French company were, therefore, practically giving them nearly £500,000 for their undertaking. On the morning of the 22nd ult. he received a telegram from Paris accepting the terms of his telegram. The question was one entirely for the shareholders, and the directors had no interest whatever in the matter which was not absolutely the shareholders' interest, but the directors unhesitatingly recommended the shareholders to approve the agreement. If, as suggested in the directors' circular, the preference shareholders received £5. 10s. a share, the preferred ordinary shareholders £5, and ordinary shareholders £3, £2,000 more than the purchase-money would be absorbed. They had, however, about £2,000 in London invested, in addition to the current half-year's earnings, which he estimated at £6,000 at least, and there would also be the interest which was to accrue on the purchase-money as from the 30th inst. The agreement provided that the money was to be paid on October 1 next, but it might be paid before, and if so the directors would have to invest it in the best way they could until the shareholders decided on the way of dividing it.

Mr. George Richardson seconded the motion, which, after discussion, was carried unanimously.

On the motion of **Mr. Concanon,** seconded by **Mr. Powell,** a resolution was passed requesting the directors to invite three preferred shareholders, two preferred ordinary shareholders, and two ordinary shareholders to confer with them as to the distribution, the number of shareholders invited to be increased if the directors thought it necessary.

ELMORE'S FOREIGN AND COLONIAL COPPER DEPOSITING COMPANY.

The seventh annual ordinary general meeting of Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, was held on Wednesday at Broad-street-avenue, E.C., Mr. F. L. Rawson presiding.

In moving the adoption of the report, the **Chairman** said the profit and loss account was given for two years instead of one year, as 12 months ago the Company was in a very difficult position—from which it had satisfactorily emerged—and they were not then in possession of the books Now, however, the ordinary creditors of the Company had been reduced from £8,440 to a little over £2,000, nearly the whole of which was due to the directors. The result of the appointment of the receiver had been that, by getting a reduction in settlement of accounts with the ordinary creditors, they had made a net profit of £698. 10s. 9d. With regard to reduction on investment through sale and surrender of securities—£39,864—the principal items were 8,000 German

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shares surrendered, £16,000; exchange of German debentures into preference shares, £10,614 (this exchange ought ultimately to mean a profit to the Company); loss on sale of German Elmore debenture stock and shares, £11,644. The amounts paid for carrying on the Company, with the exception of the amounts paid for the maintenance of the patents, had been but nominal. Nearly all the work was done by the directors, and now that the Company has been got into safety again and the work of the directors was not so onerous, it was proposed to reduce the amount of the directors' fees. The progress of the companies was comparatively slow, but was sure, and only want of money had prevented large extensions of the business. Mr. Rawson subsequently referred to the Dumoulin system of deposition as follows: "I am sorry to say that I have been unable to obtain any authentic particulars of this system, other than the *ex parte* statements of the promoters. On looking into the patent, I have come to the conclusion that it is an absolutely worthless document. The inventor claims that by coating the surface of the copper as it is being deposited with grease, he gets a better tube, as the molecules of copper are not deposited on the projecting molecules first deposited, which are covered by the grease; but they are deposited in the interstices until they become level with the projecting molecules. I am certain that his process would work better without any of this grease, which can be no improvement, and in my opinion the improved result obtained over ordinary deposited copper is simply due to the fact that he uses something in the bath which acts as a rubber or burnisher. It was originally well known to the Elmores that even such a substance as a piece of leather or felt pressed against a revolving tube will considerably improve the quality of the deposited copper, and this is fully covered in the Elmore patents. There is the objection, however, that the copper continually wears away any soft substance, the particles remaining in the bath, where they do harm. With the Elmore process as now worked the agate which acts as a burnisher is so hard that there is no objection on this score. If the Dumoulin improvement is due to the burnishing effect and not to the grease, then it is unquestionably an infringement of the Elmore patent."

Mr. J. Shurmen seconded the adoption of the report.

Mr. Julius Runges said there were several things about the balance-sheet which he did not like, and moved that the amounts be received but not adopted, and that a committee of shareholders be appointed to investigate the affairs of the Company and report to an adjourned meeting.

Mr. Boyer seconded this amendment; but it was not pressed, and in the end the original motion was carried with two dissentients.

ELECTRIC AND GENERAL INVESTMENT COMPANY, LIMITED.

The seventh ordinary general meeting of the shareholders was held yesterday (Thursday) at Winchester House, E.C., Mr. George Herring, chairman of the Company, presiding.

The report and balance-sheet were, on the motion of the **Chairman**, adopted, and a dividend making a total of 20 per cent. for the year was declared. The holders of founders' shares (£5) receive a dividend of £20 per share. The dividends are payable on June 19.

The retiring directors, Mr. George Herring and Mr. B. H Van Tromp, were re elected, and the auditor, Mr. G. T. Rait, was also re elected.

The usual votes of thanks terminated the meeting.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ecija (Spain).—The Municipal Authorities of Ecija want tenders by July 2 for a system of electric lighting for the town.

Benevento (Italy).—A concession for installing and working the electric lighting of the town of Benevento is open to be tendered for up to June 20.

Bucharest.—The Municipality want tenders by July 1 for the electric lighting of a portion of the Boulevard Coltzea. The estimate is about £3,680.

Utrera (Spain).—Tenders are wanted by the Municipal Authority of Utrera for the installation of electric lighting. The last date for receipt of tenders is July 1.

London, S.E.—Tenders are required for complete installation of electric lighting. For particulars apply by letter to Mr. H. Freeman, 44, Knatchbull-road, Camberwell, S.E.

Prestwich.—Tenders for putting into thorough repair the existing telephone system and electric bells at the county asylum, Prestwich, are invited. Full particulars on application at the asylum.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years. Tenders should be sent in by August 31.

Leeds.—The City Council invite tenders for two steel boilers and accessories for the proposed tramway electric generating station. Specifications, forms of tender, and particulars may be obtained (on payment of a deposit of £2. 2s., which will be returned on receipt of a bona fide tender) at the city engineer's office, Municipal Buildings. Tenders, endorsed "Tender for Boilers," to be sent to the town clerk's office before 12 noon on 22nd inst.

Zulz (Germany).—Tenders are wanted by June 22 for the supply of 650 telegraph poles for the Neustadt and Gogoliner line. Application to Die Bauleitung der Neustadt-Gogoliner Eisenbahn, Zülz O.-S.

Spandau.—Tenders are wanted at the Royal Small-Arms Factory for 900 incandescent electric lamps by July 17. Particulars are obtainable for 75pfg. (9d.) from Die Königl. Direktion der Gewehrfabrik (Geschäftszimmer No. 21), Spandau.

Cazeres-sur-Garonne (France).—Tenders will be received up to June 28 for electric lighting and water supply work and buildings. The estimate is about £2,043. Applications should be made to the Mairie, Cazères-sur-Garonne, Haute-Garonne.

Brussels.—Tenders will be received shortly (the exact date is not yet announced) at the Brussels Bourse for the material and work necessary to start an electric lighting installation at the fifth section of the central locomotive construction works at Malines.

Paris.—Tenders are wanted by the French Government Telegraphic Department for the supply of about 125 tons of galvanised iron wire, 3,000 cross-pieces (iron), and 100,000 screws and various accessories. Particulars are obtainable at Rue de Grenelle 103, Paris, and application for permission to tender must be made before June 15. Tenders must be in by June 25.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality. Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Huddersfield.—Messrs. Learoyd Bros. and Co invite tenders for the wiring of the Trafalgar Mills. Copies of the specifications and general conditions can be obtained from Messrs. Shepherd and Watney, 71, Albion-street, Leeds, on payment of a cheque for £1. 1s, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Electric Lighting," must be addressed and delivered to Messrs. Learoyd Bros and Co., Milnsbridge, Huddersfield, by 12 noon on July 7.

Colchester.—Tenders are required for the supply and fixing of insulated conduits, cables, switch and fuse boards, and all sundry fittings and materials for installing the electric light in the Albert School of Science and Art. Specification, with forms of tender, can be obtained from the borough surveyor on payment of £1. 1s., which sum will be returned upon receipt of a bona fide tender. Sealed tenders, properly endorsed, to be sent by 4 p.m on 23rd inst. to Mr. H. Goodyear, borough surveyor, Colchester.

San Juan (Porto Rico).—H.M. Secretary of State for Foreign Affairs has received from H.M. ambassador at Madrid a copy of a Spanish Royal Order which has appeared in the *Gazette* inviting tenders for the construction and working of a telephone system in San Juan de Puerto Rico. A deposit of 800dol. must accompany each tender which will be considered on August 10. The copy of the Royal Order may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6.

Burnley.—The Corporation invite tenders for the supply and delivery at their electric lighting station, Burnley, of armoured concentric underground cables. Specification, schedule of quantities, and form of tender may be obtained on application to Mr. W. R Wright, borough electrical engineer, on payment of £1. 1s., which will be returned on receipt of a *bonâ fide* tender. Sealed tenders, endorsed "Tender for Cables," and addressed to the Chairman of the Electric Lighting Sub-Committee, Town Hall, Burnley, must be delivered on or before the 24th inst.

Cardiff.—The Corporation invite tenders for the construction, supply, delivery, and fixing of an evaporative condenser and concentric cables. Specifications may be obtained on application to Mr. W. Harpur, M.I.C.E., borough engineer, Town Hall Cardiff. Sealed tenders, addressed and endorsed "Tenders for Electricity Works," must be left at the office of Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, by 25th inst. A fee of £1. 1s. will be charged for a copy of either of the specifications which will be refunded on the return of the specification accompanied by a bona fide tender.

Inverness.—The Highland Railway Company require tenders for the supply of (20) galvanised telegraph wire, (46) telegraph instruments and fittings, (47) telegraph construction material, etc., from July 1 next to June 30, 1897, delivered free of all charges *viâ* Dunkeld, at the storehouses, Inverness. Tenders, properly endorsed, sealed, and addressed to the directors, must be lodged with Mr. Wm. Gowenlock, secretary, Inverness, by 20th inst. Separate forms of tender will be provided for each contract; parties are therefore requested to specify the particular contract or contracts in respect of which they propose to submit tenders. Patterns can be seen at the stores warehouses, Inverness, but cannot be sent away for inspection.

Leeds.—The City Council invite tenders for an electrical installation sufficient for the working by the overhead system of haulage, a double track of tramway seven miles long. The work will be divided into the following contracts: (1) poles for supporting trolley wire; (2) underground conduits and con ductors; (3) trolley wire and attachments; (4) motorcars; (5) accumulators and switches; (6) steam-engines; (7) dynamos, switchboards, and accessories. Tenders, endorsed with the number of the contract, must be sent in, addressed to the Town Clerk, Town Hall, Leeds, by June 22. Particulars, plans, forms of tender may be had (on payment of a deposit of £2. 2s. for each

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contract, which will be returned on receipt of a bona fide tender) from the City Engineer, Municipal Buildings, Leeds; or from Dr. John Hopkinson, F.R.S., 5, Victoria-street, Westminster, S.W.

Hampstead (London).—Tenders are wanted for the extension of the electric lighting station in the parish stoneyard, Lithos-road, Finchley-road, N.W., for the Vestry of St. John, Hampstead. Drawings and specification can be inspected, and bills of quantities and form of tender obtained, on application to Mr. Arthur P. Johnson, vestry clerk, Vestry Hall, Haverstock-hill, Hampstead, N.W., between 10 a.m. and 4 p.m., and upon payment of £2. 2s., which will be returned if a bona fide tender is sent in. The person or firm whose tender is accepted will be required to enter into a written contract and to provide two sureties for the performance of contract. The expenses of contract and bond are to be paid by the contractor. Sealed tenders, endorsed "Tender for Extension of Electric Lighting Station," must be delivered at the vestry clerk's office by 4 p.m. on 25th inst.

Kingston (Jamaica).—The Colonial Government invite electric tramway contractors willing to undertake the establishment and working of a system of rapid transit to send in applications for the grant of a license by the Governor in Privy Council under the Tramways Law, 1895. In all applications the principal questions to which attention should be directed are the following: (*a*) the amount of capital which the applicants are prepared to subscribe; (*b*) the system which it is proposed to establish; (*c*) the mileage of lines to be laid; (*d*) the fares to be charged; (*e*) the frequency of the service; (*f*) the length of the license required by applicants; (*g*) the guarantee which the applicants offer for the satisfactory performance on their part of any obligations devolving on them. Plans of the city of Kingston and part of the parish of St. Andrew, showing the routes on which the present tramway lines are laid, and copies of the law under which licenses are granted and of the rules made thereunder by the Governor in Privy Council, may be seen at the office of the Crown Agents for the Colonies, Downing-street, London, S.W. All applications must be delivered not later than July 31, 1896, in a sealed packet, marked on the outside "Application for Tramway License," to the clerk of the Privy Council, Kingston, Jamaica. Kingston has its principal means of transit at present supplied by the Jamaica Street Car Company by horse tramcars, the entire length of lines laid being about 12 miles. The concession granted by the Legislature of the island to the Jamaica Street Car Company will shortly expire.

RESULTS OF TENDERS.

Bradford.—The accepted tender for the works required in the installation of electric lighting at Cliffe-road destructor works, for the Corporation, was that of Mr. G. A Steinthal, Piccadilly, Bradford.

Kensington (London).—At the statutory meeting of the Royal Palace Hotel Company it was stated that the contract for the electric wiring has been given to Messrs. Dalston, and the ironwork to Shaw and Co.

Islington.—The order for the alternators for the extension to the Islington electricity works has gone to the Ferranti Company, from whom the Vestry have just ordered two 300 kilowatt Ferranti flywheel alternators.

Tunbridge Wells.—The following tender has been accepted for various machinery and fittings at the electric light station, for the Town Council: Babcock and Wilcox, two large boilers at £543 each; small one, £264; and feed-water heater, £147.

Correction.—By inadvertence the estimate of the consulting engineer, Mr. G. R. Peers, Deansgate Manchester, for the cost of installing the electric light in the Rochdale free library was given in this column last week as if it had been an accepted tender. As a matter of fact tenders for the work have yet to be received.

BUSINESS NOTES.

Newington.—The Vestry have appointed a special committee for electric lighting.

Nottingham.—There has been a trades union meeting of workmen engaged in various branches of the electrical trades.

Kidderminster.—In the House of Commons last week the Kidderminster and Stourport Electric Tramway Bill was read a third time.

Govan.—The Commissioners' provisional electric lighting order having expired, a report on the position of affairs will be presented at the next meeting.

Hudson River Tunnel.—A bondholders' meeting at Cannon-street Hotel has approved the new scheme for carrying out the New York Hudson River tunnel.

Kensington (London).—The Vestry Committee have approved the plans for extensions of the Kensington and Knightsbridge Company and the Notting Hill Company.

Wrexham.—It is stated that the Lighting Committee have decided to recommend the Town Council to apply for a provisional order for supplying electric light and power.

Incandescent Gas.—The appeal recently lodged by the Incandescent Gas Company against Mr. Justice Wills's judgment in favour of the Sunlight system has been withdrawn.

The British Motor Company.—It is stated that this Company is about to announce a further interim dividend of 30 per cent., in addition to the 10 per cent. that was paid a few weeks ago.

Torquay.—A Local Government Board enquiry is shortly to be held into the question of electric lighting.

Personal.—Mr. J. C. Howell, of 24, Queen Victoria-street, E.C., informs us that he has ceased to represent Messrs. Crompton and Co., Limited, of Chelmsford, in South Wales and elsewhere.

Westralian Electric Lighting and Supply Company, Limited. This Company announces that the following cablegram has been received from Coolgardie: "Lighting formally opened June 6."

Newmarket.—At a meeting of the Urban District Council a motion to rescind the resolution of the Council on March 9 last with regard to adopting the electric light was lost by eight votes to four.

West Coast of America Telegraph Company.—The coupons due 30th inst. on the debentures of this Company will be paid by Messrs. Barclay and Co., Lombard-street, and should be left three days for examination.

Rochdale.—The consulting engineer for the installation of the electric light at the free library is Mr. G. R. Peers, and plans and specifications necessary for putting the work out for tender have been prepared by him.

Dundee.—The estimated income in the electricity department of the Town Council, where it is proposed to grant 5 per cent. discount on prompt payment, is £5,225 and the expenditure is put down at £4 493. 14s. 4d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending June 14 amounted to £1,176, as compared with £1,268 in the corresponding week of the previous year, being a decrease of £92.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending June 13 were £2,146. 3s. 11d., compared with £1,877. 1s. 1d. for the corresponding period of last year, being an increase of £269. 2s. 10d.

Bearpark (Durham).—The village has recently been provided with the electric light, and to commemorate the completion of the installation the parish councillors have been entertained at supper by the engineers, Messrs. Cox-Walkers, of Darlington.

Hammersmith.—The Electric Lighting Committee of the Vestry have accepted the tender of Messrs. Leslie and Co., of Kensington-square, for the purpose of carrying out the following work: boiler-house and engine-house £5,281, and shaft £1,950.

Camberwell (London).—The Electricity Committee have reported that the modifications introduced into the order of the County of London and Brush Provincial Electric Lighting Company do not affect the principle of the Vestry's recommendations.

Hermite International Electrical Sanitation Company, Limited.—This Company has been floated to deal with the several inventions, patents, and patent rights collectively, known as the Hermite patents, for bleaching, electrolysing, disinfecting, purifying, sanitary, and other processes.

Fort-William.—The works of the electric lighting company are in an advanced state, and it is expected they will be in use on July 1. An electric storage station has been erected at the head of Bank street, and at present the overhead wires are being run and the cable laid through the town.

Chester.—The Town Council have opened a credit for the Electric Lighting Committee at the bank to enable the committee to pay the certificates to be given from time to time by Prof. Kennedy, pursuant to the contract with Thomas Parker, Limited. Five thousand pounds will be placed to the credit of the committee.

City and South London Railway.—The returns for the week ended June 14 were £877, compared with £862 for the corresponding period of last year, being an increase of £15. The total receipts for the half-year terminating as above were £22,342, compared with £22 299 in the same period of the preceding year, being an increase of £43.

Alternate-Current Transformers.—Messrs. Johnson and Phillips remind us that they are the absolute and sole proprietors of all Mr. Gisbert Kapp's patents for transformers, and point out that manufacturers claiming to put on the market transformers made from Mr. Kapp's designs render themselves and their clients liable to action at law for infringements of patents.

Ostend.—A sum of about £24,000 has been placed upon the estimates of the current year in connection with works projected by the late Colonel North on the Ostend coast. The Belgian Government, which is amply secured, has undertaken to intervene in the establishment of electric works, etc., conceded to Colonel North by the convention of January 25 of last year.

Eccles.—The Local Government Board enquiry into the application of the Corporation for sanction to borrow £20,000 for electric lighting was resumed last Tuesday. This time there was great opposition on account of the increase to the rates which would ensue from the adoption of the scheme. The Corporation have several other schemes in hand and under consideration.

Paddington.—At a meeting of the Baths Commissioners a letter was read from the Metropolitan Electric Supply Company informing the Commissioners that there would be a reduction in future in the price charged to them for the electric current used at the baths. The effect of this communication will be that 6d. will have to be paid for the amount for which hitherto 7d. has been charged.

Tourist Guide to the Continent.—We have received a copy of the Great Eastern Railway Company's guide-book to the Continent for the current year. This is the seventeenth annual issue, and we can only repeat what has been said before—that the book is most useful and very concise. Among its fresh features are a

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series of Continental maps, a chapter upon cycling routes in Holland, Belgium, and Germany, etc.

Cowes.—At a meeting of the Council, with regard to the application of the National Telephone Company to lay wires to Osborne, it was resolved that permission be given provided the wires are laid underground and in such a position as the surveyor may direct, that a deposit of £10 be left with the surveyor till the roads were made good to his satisfaction, and that plans be supplied.

Ashbourn.—Mr. John Shaw, jun., who is officially associated with the scheme for an electric railway from Derby to Ashbourn, has written to the Rural District Council stating that as soon as the Light Railways Bill has passed through Parliament the scheme will be again submitted to the public for approval. The Council declined to discuss the scheme until the Light Railways Bill had received the sanction of the Legislature.

Newport (I W.).—At a meeting of the Isle of Wight Highways Committee, a letter was read from the National Telephone Company asking permission to erect poles and wires by the side of the highways for the purpose of providing telephonic communication between the various island towns. It was agreed to grant permission where the roads were 15ft. wide, 3s per mile to be charged as a kind of acknowledgment rental, instead of 1s as offered by the company.

Dundee.—At the annual meeting of the directors of the Royal Lunatic Asylum it was moved that a remit be made to the Committee of Management to have the asylum and Gray House lighted with electricity. From enquiries which had been made it was found that the cost of the installation would be about £1,500, or, at the outside, £2,000. It was agreed that estimates should be submitted to a special meeting of the Board to be held to consider the whole subject.

Mitchelstown.—At the meeting of the Guardians a deputation attended in reference to a scheme to light the streets by electricity. Mr. Roche said it was proposed to borrow a sum of £330 from the Board of Works for the erection of plant. It was originally intended to have 36 electric lamps, but it was expected that they would be able to reduce this number to 25 The cost would be about £1 per lamp annually. A resolution was carried that application be made for the necessary powers.

Wolverhampton.—The Town Council have instructed the Public Works Committee to consider the advisability or otherwise of the Corporation exercising on the expiration of the term of 21 years mentioned in Section 43 of the Tramways Act, 1870 their power under such section to purchase the portion of the undertaking of the Wolverhampton Tramways Company within the borough The committee will also consider the question as to who shall work the tramways, and what system shall be adopted.

London Extensions.—The Highways Committee of the London County Council have passed notices from the Vestry of St. Pancras of intention to lay a telephone wire from the Gray's-inn-road electric lighting sub-station to that in Well-street; from the County of London and Brush Provincial Electric Lighting Company to lay low-tension mains in Myddelton-street, Clerkenwell; and from the Metropolitan Electric Supply Company of intention to lay mains in Great Turnstile from Newman's-row to Holborn.

Portsmouth.—At a meeting of the Town Council one of the clauses in the Electric Lighting Committee's report recommended that an engine of 1,000 h.p. should be ordered from Messrs. Ferranti at a cost of £6,200. In addition, there would be the cost of the fittings and connections, and it would be necessary to provide two larger feeders for supplying the electric current in different directions. It was further recommended that application should be made to the Local Government Board for sanction to borrow the sum of £10,000. The report was adopted.

Paisley.—At a meeting of the Electric Lighting Committee it was agreed to recommend acceptance of the Brush Company's offer for wiring the town hall at £844, provided the specimens of wire submitted are satisfactory. At a subsequent meeting a number of offers of ground for a central electric lighting station were laid on the table. The Town Council at the last meeting decided to leave over the consideration of these until an engineer has been appointed to advise as to the most suitable site, and that a resident engineer be at once advertised for.

Ashton-on-Mersey.—The Urban District Council have decided that Mr. Slater and the law clerk (Mr. Briggs) shall see the solicitors of the Altrincham Electric Supply, Limited, and intimate that the Council are prepared to agree to the provisional order, and will enter into an agreement giving the Council similar action in the Bucklow Rural District Council. If they decline to do so, the law clerk is to be empowered to write to the Board of Trade with reference to the provisional order, in so far as regards the breaking up and repair of roads and streets.

Fulham.—At a meeting of the Electric Lighting and Dust Destructor Committee of the Vestry Mr. F. H. Medhurst brought up a report in which he estimated that the cost of a destructor would be £12,800, destroying 22 000 loads at 1s. per load £1,100 The combined scheme for providing the electric light and a dust destructor was estimated to cost £54,500, and the net annual profit on the combined scheme was £1,659. 11s. The committee eventually decided to interview Mr. Medhurst with a view of seeing other destructors at work before they decided one way or the other.

Barrow.—At the County Council meeting letters were read from the general manager of the Furness Railway and the managing director of the Naval Construction and Armaments Company with regard to electric lighting. The borough engineer was instructed to see the general manager of the Furness Railways in reference to his letter. It was resolved that the town clerk write the liquidator of the Barrow Tramways Company asking whether, in the event of an installation being laid down the company would be prepared to take electricity for the purposes of working their tramways.

The City and Guilds of London Institute.—In response to an advertisement recently issued by the Executive Committee for a professor of mechanical engineering and applied mathematics at the Technical College, Finsbury, 17 applications have been received. The position has been rendered vacant by the appointment of Prof. Perry to the Royal College of Science, South Kensington. The salary attached to the position is £600 per annum, and the appointment will date from September 29. The Executive Committee will deal with the applications in the course of a few days, and the result of their investigation will be duly announced.

Grimsby.—At the meeting of the Town Council, Alderman Dobson moved the adoption of a recommendation of the Lighting Committee that a new dynamo for the electric lighting installation of the town hall be purchased at once, and that the tender of Messrs. P. R. Jackson and Co, for a dynamo with an output of 110 volts, at a cost of £144. 10s., be accepted. Alderman Evison seconded the proposition. Mr. Moss moved, as an amendment, that the matter be referred back to committee. He understood in the first instance that the new dynamo was to be placed alongside the present one. Mr. Wright seconded the amendment, which was carried.

Cardiff.—At a meeting of the Lighting Committee a letter was read from the electrical department of the General Post Office London, with regard to the lighting of the new post office at Cardiff The authorities are preparing to light the Cardiff office by electricity, and desired to know the lowest rate at which they could be supplied by the Corporation. A low estimate fixed the consumption at 60,000 units a year, and it was likely to amount to 80,000 units. Mr. Appleby stated that it would be necessary to ascertain whether it would be all day running or all night running before a price was given. Mr Appleby's report showed that there was a steady increase in the electricity used for lighting purposes.

British Motor Carriage and Cycle Company, Limited.—This Company was registered on June 5 by Lumley and Lumley, 37, Conduit street, W., with a capital of £200,000 in £1 shares. Object: to acquire, by purchase or otherwise, patents for any description of motors, cycles, carts, wagons, vehicles, ships, boats, launches flying machines, carriages, etc., and to use, exercise, develop, grant licenses in respect of, and turn to account the same, and to carry on in all or any of their respective branches the businesses of motor cycle and carriage manufacturers; also as electricians and electrical engineers, machinists, fitters, founders, millwrights, smiths, wire drawers tube makers, metallurgists, saddlers, etc.

Ayr.—At a meeting of the Town Council Mr. E. G. Pink, burgh electrical engineer, in his monthly report stated that the plant continued to run as well as ever. The mains had been finally tested and taken over and the contractors' work was completed. With the exception of the sub station they were still working on Swinburne and small Fowler transformers, which might give trouble at any time. The new street lamps supplied by Messrs. Fowler were an improvement. At present, however, they were taking too much current, and they were waiting the arrival of the new choking coils from Leeds to reduce the current to 16 amperes. The Wallacetown lamps could not be fixed at present as the transformers were required at the works for testing.

Fareham.—At a meeting of the Urban District Council it was recommended that 17 arc lamps should be placed in High-street and West-street, that earthenware conduits should be used, as proposed by Mr. Manville, and placed under the pavement. The report also recommended that second hand plant should be purchased. The cost of carrying out the work and the purchase of the plant was estimated at £2,800, to which was added a sum of £200 for the piece of land adjoining the electric light works. It was also recommended that the Council should at once enter into a contract to purchase and fix all the plant as soon as possible, and should apply to the Local Government Board for sanction to obtain a loan of £1,900 for the carrying out of the work. The report was adopted.

Watford.—A long discussion took place at the Urban Council meeting with regard to the electric lighting question, and ultimately the following resolution was passed: "That this Council is of opinion that it is desirable to issue advertisements in the electrical newspapers seeking applications from eminent consulting engineers to advise the Council in the preparation of their application for a provisional order from the Board of Trade, as to the best system to be adopted, and generally as to the cost of the undertaking, the area to be lighted, and also as to its probable development Engineers to state their fee for such preliminary report and advice, the Council giving no guarantee as to subsequent employment. The engineer to advise the Council as to whether they control the powers in their own hands or dispose of them to a company or otherwise."

Appointments Vacant.—The Technical Instruction Committee of the borough of West Bromwich invite applications for the post of assistant lecturer and demonstrator in metallurgy, chemistry, and physics. Salary, £100 per annum The teacher appointed must be specially qualified for teaching metallurgy. Applications (accompanied by copies of not more than four recent testimonials) to be sent by 30th inst. to the secretary, Mr. T. Gilbert Griffiths, from whom further particulars may be had on application. Canvassing for the appointment is not permitted.—The Burgh of Paisley are advertising for a resident electrical engineer to design

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and superintend the laying down of a central installation and to manage the same after completion. Salary to commence with £200. Applications, with testimonials, to be lodged with the town clerks on or before July 1. Canvassing members of the Council is prohibited.

Bingley.—At a meeting of the District Council the chairman of the Gas Committee recommended the adoption of electric light. He had been in communication with the directors of the Leeds and Liverpool Canal Company, who were prepared to erect the necessary plant at the bottom of the Three Rise and Five Rise locks, and supply the town with electricity, the Council bearing the cost of distribution. The directors believed that they could produce at those points electricity equivalent to 20,000,000 cubic feet of gas, a quantity which he found was consumed by the mills, the Midland Railway Company, and the hotels every year. Therefore, if those places could be induced to take the electric light it would relieve the Council from the necessity of making costly extensions of the gasworks. He did not think there was any doubt but that by this means electricity could be produced cheaper than by any other way. He could not tell them what price it could be retailed at per unit, but it would not have to be more than the Bradford price. The motion was adopted without discussion.

Manchester.—A new electric light installation has been established by the Ship Canal Company at Trafford Bridge. The installation which has been displaced was of merely a temporary character, power being supplied by no less than three different generating stations. On the recommendation of Mr. Hunter, the company's engineer, Mr. Fawcus, of the Manchester Edison-Swan Company, was consulted, and under his advice the new installation has been carried out. There are two sets of compound inverted cylinder vertical engines of 100 h.p., made by Mr. Goodfellow, of Hyde, and two sets of 30-h.p. engines made by Messrs. Browett and Lindley, of Patricroft, the alternators and exciters being supplied by Messrs. Baxendale and Co., of Miller-street, Manchester. The lighting area includes the Manchester and Salford Docks and the locks at Mode Wheel, together with the road to the locks. There are 66 arc lamps, continuous current, 28 alternating arc lamps of 2,000 c.p. each, 360 incandescent lamps of 50 c.p. each, 100 of 32 c.p., and 28 of 16 c.p. Inside the sheds incandescent lamps alone are used.

The London Tramways Question.—The secretary of the County of London Tramways Syndicate, Limited, has addressed a letter, dated June 15, to the clerk of the London County Council, in the course of which he states that, "Inasmuch as the requirement on the part of the County Council of a 14 years' lease would involve injury to the companies and prejudice to the travelling public without sufficient benefit to the ratepayers, my directors feel that it would be unworthy of the spirit in which they entered upon their negotiations to propose the modifications indicated in your letter now under acknowledgment. If, however, contrary to the recommendation of the Highways Committee, the Council, undeterred by the obstructive litigation of the companies, should prefer to accomplish the early consolidation of all the lines within its jurisdiction, and to secure the benefits of a comprehensive system of intercommunication as forshadowed in the original proposals of the syndicate, my directors will be prepared, if called upon, to discuss a tenure of 21 years on the basis of a purchase clause, which provides for the redemption of one-third of the expenditure to be amortised by the syndicate under the plan it has promulgated."

Ealing.—At the meeting of the District Council, the Finance Committee reported that they had inspected the profit and loss account of the electric lighting department for the year ended March 31 last, and the account was considered very satisfactory. The Chairman said the accounts had to be signed by himself and the clerk before being forwarded to the Board of Trade. He only received a copy that morning, and he had not had sufficient time to look into it yet. After some discussion, the chairman was authorised to sign the accounts if he found them correct and in proper form. The profit and loss account shows that the cost to the rates on the first year's work has only been about £800. The Electric Lighting Committee reported that the orders received represented 7,144 8-c p. lamps, and of these 6 036 had already been connected. Mr. Griffin asked what was the estimated revenue from the private supply for the present year The Surveyor said it was difficult to give exact figures. The average number of private lamps in use in the past year was about 3,000; the average for the present year would certainly not be less than 6,000. He estimated an addition to the revenue of £1,500, with very little addition to the expenditure.

Leeds.—The Corporate Property Committee have decided to recommend the Council to adopt Alderman Harding's scheme for the laying-out of the City-square, in which the electric light will play so prominent a part. Plans have been prepared by Mr. Wm. Bakewell, architect, Leeds. The *Yorkshire Post* hears that numerous engineering firms in various parts of the country have applied to Dr. Hopkinson, the expert in electric traction to the Corporation, and to the city engineer for specifications, apparently with the object of tendering for the principal portion of engineering work to be done in connection with the experiment with electric traction to be made between Roundhay Park and Kirkstall. In response to the urgent representations of numerous engineers, the committee have determined that the engines shall be horizontal. Sundry alterations have also been made with reference to the driving gear and a few details of minor importance. Tenders are to be sent in by 22nd inst. At a meeting held the other day, the Tramways Committee empowered a sub-committee to enquire as to what outlying district of the city extensions of the tramway system would be most acceptable in. The committee seem to think that the first extension to be taken in hand should be from the existing York-road terminus to the East-end Park. The sub-committee intend to visit various parts of the city in which tramway extensions are desired or desirable.

Morecambe.—In moving the confirmation of the Electric Lighting Committee's report, which stated that Mr. Thomas Parker, of Wolverhampton, had been appointed consulting engineer, Mr. Bellamy explained at the meeting of the District Council why Mr. Parker had been employed by the committee. He would like to refer to an item relating to the probable cost of the undertaking, which was £20,500, as quoted by Mr. Parker. To that amount must be added £505 for land and also the amount to be paid to the electric light company, which would bring the total to £25,000. When Mr. Parkinson, of Morecambe, gave the Council an estimate it was £16,000, being £9,000 difference Mr. Parkinson estimated £16,000 for buying the electric light company's plant, erecting works for the supply of private lights and also the lighting of the streets, the promenade from the Battery to East View to be lighted by 40 arc lamps. Mr. Parker's estimate was different altogether, as he embraced the whole of the district, including Bare and Torrisholme, also the new sea-wall which would probably be built in the future, the promenade to Bare White House to be lighted with 100 arc lamps. Two thousand pounds were estimated for meter rents, but he (Mr. Bellamy) would be pleased if that could be realised. Mr. Miller seconded the adoption of the minutes. In reply to Mr. T. Baxter, the Surveyor stated that he had tested the site selected by Mr. Parker and found good clay 12ft. down. He thought with concrete it would make a good foundation. It was resolved that the Electric Light and the Lighting and Water Supply Committees should be amalgamated, should consist of the whole Council, and should be called the Lighting and Water Supply Committee.

Edinburgh.—At a meeting of the Town Council the Electric Lighting Committee submitted the following report by the consulting engineer (Prof. Kennedy) as to the condition of the plant and mains and the working of the electric lighting station for the year 1895-96: "I have much pleasure in making a report to the Corporation of Edinburgh on the first year's working of their electric light station. The station opened on April 11 last year with about 2,000 lamps on circuit. On May 15, therefore—that is, at the end of your financial year—the station will have been running for 57 weeks. The number of lamps actually connected to the mains is now 51,900, besides 247 arc lamps, equivalent to about 4,500 incandescent, making the total number of lamps connected equivalent to 56,400 lamps of 8 c.p. The number of private consumers connected to the mains of the Corporation is 445; in April, 1895, it was 48. I am extremely glad to be able to say that the financial success of the enterprise has corresponded to the great demand for light. The accounts are not, of course, as yet made out to May 15, but the final weekly reports allow us to estimate all the figures very closely. The total income from incandescent lighting, allowing for meter rents and after deducting all rebates, will be about £13,300. The total income from arc lighting will be about £3,500, making in all an income of about £16,800, or possibly a little more. The total station expenses, including all expenses in trimming arc lamps and supplying carbons, and in maintenance of mains, etc., have been about £4,500. Standing charges, as stated by the town clerk including interest and sinking fund, and also including general charges against the department, amount to about £9 450, making altogether £14,000, and therefore leaving a net profit balance of £2,800. Out of this balance allowance has to be made for depreciation, and I have given this matter very careful consideration. I understand that your sinking fund amounts to 3¼ per cent. per annum—that is to say, that you put by, on account of sinking fund, one-thirtieth of your whole capital expenditure every year. Under these circumstances I do not think it is necessary that you should make any special further depreciation allowance on any items of expenditure which will last for 30 years—that is to say, on which you would not naturally put a higher rate of depreciation than 3¼ per cent. I think that you may consider that all buildings, mains, road-work, and lamp-posts come under this head, and that, therefore, on these items you need not allow any further amount of depreciation. On plant, however, of every kind it would be well that you should allow a total of 5 per cent. for depreciation, or, say, 2 per cent. in addition to what is allowed in the sinking fund. I believe this amount would run on £24,064 of your expenditure, and would therefore involve an additional allowance of £480. On batteries, instruments, arc lamps, meters, transformers, rectifiers, and one or two other matters, on which you have in all expended the sum of £7,850, I think it would be advisable to allow a total depreciation of 10 per cent., or, say, 7 per cent. more than you have already allowed. This would require an additional allowance of £550 altogether, so that you would require a total allowance, in addition to the sinking fund, of, say, £1,030 for depreciation, and this will still leave you a clear balance of from £1,700 to £1,800. I do not attempt to put the figures more exactly than this, because the accounts are not yet made up. The total number of units sold during the 57 weeks from the start until May 15 have been about 560,000 to private consumers and 328,000 for street lighting—in all about 888,000. Your actual works cost per unit will at this rate be under 1·25d. per unit, including lamp trimming and carbons; and if this figure is reached it will be the lowest yet obtained in the country, a result of which I think your Corporation, and in particular the staff at the station, may be justly proud. I went over with Mr. Monkhouse some time since his estimate for

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the expenditure and receipts for the coming financial year 1896 97, which has already been before your committee. The figures in this estimate as finally adjusted appear to me to be reasonable, and I believe that the actual results will, at any rate, not be behind them. In the estimate the receipts for current are put at £28,000 during the year. The reduction of price from 6d to 5d. in the case of private consumers, and from £20 to £18 in the case of arc lamps, will make a total difference of about £4,100 on the estimate, but this will still leave an ample margin over the expenditure, even without allowing for what I hope may be the fact, that the reduction of price will considerably accelerate the rate at which lamps will be put on to your system." The Town Council has agreed to supply the infirmary with electric light.

PROVISIONAL PATENTS, 1896.

JUNE 8.

12481. Improvements in bracket and chandelier arms for gas, oil, or electric light. Samuel Eaton, Thomas Eaton and Samuel Eaton, jun., 72, Barr-street, St. Georges, Birmingham.

12504. Improvements in or in connection with the transmission and or transformation of electric currents specially applicable for lighting purposes. Bernard Page Scattergood, 30, Park-row, Leeds.

12531. Improvements in switches for making and breaking electric currents. Alfred Slatter and William Rixon, 7, Ridgmount-street, Bedford-square, London

12549. Improvements in and in the manufacture of elements for secondary batteries. Desmond Gerald Fitzgerald, 53, Chancery lane, London.

12550. Improvements in electrical circuit-closing thermometers Alexander Luraschi, 53, Chancery-lane, London.

JUNE 9.

12581. Improvements in the method of supplying electricity to electrically-propelled tramcars and other vehicles, and in apparatus therefor. Percival John Pringle and Julian Money Vernon Money-Kent Morningside, High View-road, Sidcup, Kent.

12587. Improvements in telescopic support for telephone transmitters. Robert Baker, John Filmer, Edgar Lee Ryder, and Alfred Gartner, 18, Fulham-place, Paddington, London.

12588. Improvements in telephone receivers. Robert Baker, John Filmer, Edgar Lee Ryder, and Alfred Gartner, 18, Fulham-place, Paddington, London.

12635. Improvements in electrical switches. George Senior jun., and Thomas Duncan Dundas 44, Blythe-road, London.

12637. Improvements in electric machines and in the method of operating the same. William Henry Cooley, 55, Chancery lane London.

12650. Improvements in thermo electric generators. Harry Barringer Cox and the Cox Thermo-Electric Company, Limited, 46, Lincoln's-inn-fields, London. (Complete specification.)

12676. An improved dynamometer. Jean Benoît Granjon 18, Buckingham-street, Strand, London

12696. Improvements in electrical accumulators. Xavier Marie Roux, 24, Southampton-buildings, Chancery-lane, London.

JUNE 10.

12738. System for the indoor distribution of the electric light. Victor Planques, 8, Rue des Princes, Brussels.

12746. Improvements in two-pin plug for portable electric lamps. William John Head, 60, Chesnut-road, Tottenham, London.

12755. An improvement in the manufacture and insulation of electrical conductors. The Telegraph Manufacturing Company, Limited, Helsby, near Warrington.

JUNE 11.

12859. Improvements in electric transformers. Leslie Bradley Miller, 2, Gray's-inn-road, London

12895. Electric elevators. Humphrey Russell Smith, 260, Dearborn-street, Chicago. (Complete specification.)

JUNE 12.

12959. Improvements in arc lamps specially applicable for lantern purposes. Frederick Woodward Branson, 30, Park-row, Leeds.

12963. An improved grid or plate for secondary batteries. Richard Norman Lucas, The Voltage, Woking, Surrey.

13023. Improvements in casings for electric conductors. Henry Reason, Norfolk House, Norfolk-street, London.

JUNE 13.

13046. Improvements in and connected with cleats for electric and other wires and the like. Frederic Brigham Evans, 23, Coleman-street, London. (Complete specification.)

13048. An electric lamp and oil-can combined. James Rhodes and James Henderson, Bridge End, Wakefield.

13074. Improvements in the manufacture of electrical resistances. Augustus John Marquand and David Lowden, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13079. Improvements in or connected with dry batteries and the like. William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Christian Lesenberg, Germany.) (Complete specification.)

13080. Improvements in or applicable to electric meters. Albert Lotz, 6, Bank-street, Manchester. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1889

19420. Electromagnetic motors. Lake. (Tesla.) (Second edition.

1894.

10632. Electrolysis. Gautier. (Second edition.)

1895.

10250. Telephone systems. Sloper.

10359. Gas and electric light fittings, etc. Lancaster.

10746. Incandescent electric lamps. Benham and Smith.

11153. Motor-generator transformers. Blackburn and Spence.

11951. Telephonic exchange. Berditschewsky, called Apostoloff. (Second edition)

13444. Electric heating apparatus. March.

13530. Telephones. Hamm and others.

13695. Electric railway carriage, etc, lamps. Headland.

15470. Asynchronous electrical machines Abel. (Société Anonyme pour la transmission de la force par L'electricité.)

17821. Secondary batteries. King.

17825. Porous plate, body, or electrode. Beck. (Johnson and another)

21523. Supplying electric power to railway vehicles, etc. Sayer.

23865. Thermo-electric generators. Boult. (Wunderlich)

1896.

3375. Electric contact devices for clocks, etc Paynter and Walker.

4434. Secondary battery p ates. King.

5191. Electric railways. Petzenbürger.

7791. Electric stop motions for engines St Peter.

7882. Electric motors. Devonshire. (Potter.)

8141. Electrometers. Siemens Bros. and Co. (Siemens and Halske.)

8316. Electric switches. Wright and others.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅞-6⅛
Brush Company, Ordinary	2	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2	1⅞-1⅞
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	8⅛-8⅜
Chelsea Electricity Company	5	7⅛-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14⅜-15½
—— 6 per cent. Cumulative Pref.	10	16½-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	14⅜-15½
County of London and Brush Provincial Co., Ordinary	10	8½-9½
—— 6 per cent. Cum. Pref.	10	12½-13⅝
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1½-1⅝
—— 4½ per cent. Debentures	100	105-108
Electric Construction, Limited	2	1½-1⅝
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	1⅛-1⅜
Elmore's Wire Company	2	1⅛-1⅜
W. T. Henley's Telegraph Works, Ordinary	10	16½-17½
—— 7 per cent. Preference	10	17-18
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	3⅜-3⅝
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	105-107
Isle of Man Electric Trams, Ordinary	1	1⅜-1⅝
—— 6 per cent. Preference	1	1⅜-1⅝
Kensington and Knightsbridge Ordinary	5	9-9½
—— 6 per cent. Pref.	5	7⅛-8
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	17⅛-17½
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	1-1⅛
Metropolitan Electric Supply	10	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-122
National Telephone, Ordinary	5	7⅛-7⅜
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	9½-9¾
Oriental, Limited, £1 shares	1	1⅛-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5½
St. James's and Pall Mall, Ordinary	5	11-11½
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary		8-8½
Westminster Electric Supply, Ordinary	5	9⅞-10½
Yorkshire House-to-House	5	7⅛-

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NOTES.

Dundee Institute.—The annual general meeting of the Dundee Institute of Architecture, Science, and Art, will be held on Tuesday, 30th inst.

The Marine Engineers.—The annual dinner of the Institute of Marine Engineers was held last week at the Holborn Restaurant, Sir Edwyn Sandys Dawes, the president, being in the chair.

Accident.—It is with very great regret that we learn that Mr. Lennox, of the laboratory at the Royal Institution, has received terrible injuries from an explosion of apparatus containing acetylene under high pressure.

Books Received.—We have to acknowledge the receipt of "Electricity in the Dwelling," an address delivered to the Royal Scottish Society of Arts by the Right Hon. J. H. A. Macdonald, F.R.S. It is published by Messrs. Blackwood and Sons.

Lord Kelvin.—It is announced that Lord Kelvin will preside at the unveiling of Mr. W. D. Stevenson's bronze statue of "Highland Mary" at Dunoon, Argyllshire, on August 1. The statue is intended to commemorate the centenary of the death of Robert Burns.

A French Tangiers Cable.—It has been reported from Tangiers that the French Government intends to lay a telegraph cable between Tangiers and the coast of France or a French possession. Of course, it is quite impossible to tell what projects may have been discussed or decided on in French Government telegraphic circles, but the report, to say the least, requires confirmation.

Utilising Water Power.—The *Bradford Observer* hopes, "if only for the scientific novelty as regards this part of the country, where water power is scarce," that the Bingley District Council will be able to come to terms with the canal company in regard to the offer of the company to supply the town with electricity from dynamos driven by the power which at present goes to waste at the canal locks.

Catalogue of Scientific Literature.—The approaching international conference arranged by the Royal Society to consider proposals for an international catalogue of scientific literature will be opened at Burlington House on July 14. The total number of delegates appointed to attend the conference amounts to 40, including representatives of the principal colonies of the Empire and the principal Governments of the world.

Chicago Exhibition.—The medals and diplomas awarded to British exhibitors at the late Chicago Exhibition have at length been issued to H.B.M. Ambassador at Washington, and have been transmitted by him to the Foreign Office. Sir Henry Trueman Wood has been requested by the Secretary of State to undertake the duty of distributing them, and this will be done at once. All the exhibitors may expect to receive their medals within about a month from the present date.

Obituary.—Mr. John Lionel Blakiston, one of the two telegraphists killed on the rescue party from Fort Salisbury to Mazoe on Saturday last, was the third son of the Rev. Douglas Y. Blakiston, vicar of East Grinstead, Sussex. He had been in South Africa in the service of the Government Railway Department, when he was offered a post on the trans-continental telegraph construction, for which he was qualifying by work between Victoria and Charter, and since March at Salisbury.

Society of Arts.—The council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a gold medal, or a prize of £20, for any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means. Intending competitors should send in descriptions of their inventions not later than December 31, 1896, to the secretary of the Society of Arts, Adelphi, London, W.C.

Carriage Makers and Motorcarts.—In the course of his address to the Institute of Carriage Manufacturers on Tuesday, Mr. G. J. Jacobs (the president) referred to the subject of motorcarts. He was inclined to regard the advent of the "autocar" without alarm, and if the result of it should be that the carriages of the future were increasingly light, easy, and elegant carriage makers had nothing to fear from, but for many reasons they would welcome, the new comer. At the dinner in the evening Sir Henry Trueman Wood, in proposing the principal toast, spoke to somewhat similar effect.

Acetylene Motor.—According to the *Rivista Tecnica*, Mr. G. Pedreti, of Parma, has invented an acetylene motor which he believes will be suitable for small motor carriages and tricycles. He uses a mixture of one-sixteenth of acetylene to fifteen-sixteenths air, and it is stated that a water-jacket on the cylinder is not necessary, as the cooling is done by the admission of the mixed gas and air, from which it may be fairly inferred that it is proposed to generate the acetylene under pressure. As the details of the machine, including the method of ignition, are at present kept secret, it would be premature to criticise the extremely favourable results which are said to have been attained.

Electrical Congress at Geneva.—Invitations are now being sent out for the International Electrical Congress organised by the Swiss Society of Electrical Engineers, and to be held from August 4 to 9 next. Information relative to the congress will be given at the office of the International Electrical Congress at the Université, Geneva, and all who may desire to take part in the congress should apply there. The programme of subjects for discussion has already been given in these columns, and papers to be contributed should be sent in in MS. before July 20. It is worth note that the sittings of the congress are fixed for 8 a.m. Mr. Raoul Pictet has promised a demonstration on the subject of low temperature and on "Cathode Rays." The price of a ticket for the congress is 20fr. and 15fr. for a lady.

Rontgen Radiations.—Mr. T. C. Porter, of Eton, has written to *Nature* a long letter describing some curious results of his experiments. In comparing the results obtained by different observers it seems that it is important that the exact temperature should be given, though it does not appear how far Mr. Porter eliminated the direct effect (if any) of temperature on the discharge with its indirect action in affecting the vacuum. A second curious result comes to this—namely, that any arrangement by which a charge on the outside of the tube behind the cathode would be subject to intermittent removal (for instance, a ring of copper wire earthed, and nearly, but not quite, touching the glass of the tube) greatly increases the fluorescence and photographic action of the discharge, as well as prevents "fatigue" of the tube.

Incandescent Gas Patents.—After a three days' hearing, the Master of the Rolls and Lords Justices Kay and Smith have dismissed an appeal by De Mare Incandescent Gas Light System, Limited, and (on a minor point) the Sunlight Incandescent Gas Lamp Company, Limited, from the judgment of Mr. Justice Wills, in April, at the suit of the Incandescent Gas Light Company, Limited, holding the defendants to have infringed

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the plaintiffs' Welsbach patent in gaslight mantles. Their lordships, however, were unanimous in agreeing with Mr. Justice Wills and his ruling, on the authority of Lord Cairns, that it was sufficient to establish infringement to show that the substance and essence of a patent had been taken and adopted, as Mr. Justice Wills said had been the case in the present instance.

Institution of Electrical Engineers.—We have received the June issue of the *Journal* of the Institution of Electrical Engineers, containing Mr. Dane Sinclair's paper on "Telephone Exchangcs" and Mr. Langdon's on "Railway Telegraphs," with the discussions. It will be remembered that, in view of the close of the session, the discussions had to be kept within very strict limits of time. Hence there are several interesting communicated additions to these. Among them we notice that Mr. Hollins, of the Great Eastern Railway, incidentally promises a paper on electric interlocking of railway signals for next session. As to the abstracts, there are 16 of them, of which six relate to the subject of the Röntgen rays. By permission of Major Cardew, arrangements have been made for a visit of students of the institution to the Board of Trade standardising laboratory, 8, Richmond-terrace, Whitehall, on Saturday, July 4, at 11 a.m. The party is limited to 20, and students desirous of being included in it should signify their intention to Mr. G. C. Allingham, Eldon House, Lyndhurst-road, Hampstead, N.W., in the usual manner.

Alternating-Current Motors.—The Langdon Davies alternating-current motor is a self-starting one. Two circuits are used, and the motor differs from others designed on similar principles in the careful way in which the proper arrangement and proportion of the coils has been worked out. The motor has received the honour of a description in the *Times*, which begins with the ingenuous remark that "the alternating-current system of distributing electrical power is generally admitted to have distinct advantages in comparison with the direct-current system." All the direct-current people—who, it is understood, have usually something to say for themselves—having been thus summarily ruled out, it is added that the polyphase system "is not very common." Certainly it is not—at present—in Great Britain. Moreover, though, of course, everyone would like to see a good alternating-current motor, the question of motors is hardly one which would determine the preference of a continuous-current system. In fact, up to the present motors have taken a very minor place in the calculations of the electrical engineer.

Resistivity of Alloys.—That troublesome conception, the "back E.M.F. which is proportional to the current, and therefore in measurements is not separated from a resistance," has appeared in a new place. It has been heard of in connection with the arc, and now Lord Rayleigh wants to find a place for it in the abnormal resistivity of alloys in Prof. Dewar and Prof. Fleming's low-temperature experiments. At any rate, in a letter to *Nature*, he points out that in a material made up of a large number of small laminæ, when the current flows across them heat would be produced at one set of the junctions and increase until balanced by conduction through the metal to the other junctions. Considered thermo-electrically, the result works out as a back E.M.F. proportional to the current, but (probably) independent of the number of laminæ. Lord Rayleigh considers that something analogous to this action should have some bearing on part at least of the resistivity of alloys. It should be said, however, that in the example he works out the percentage of the false resistance is a very small one. Moreover, distinctions which are clear cut enough in dealing with masses of matter of appreciable size may easily change their character when we get into the region of the molecules and atoms whose structure and motion determine the properties with which we are dealing. It therefore seems at least questionable how far the extension of the theory indicated above into such regions is legitimate.

London Tramways.—The London County Council have discussed the report of the Highways Committee with reference to the proposals of the County of London Tramways Syndicate with reference to leasing the lines and introducing electric traction. The recommendation of the committee was that the syndicate should be informed that the Council were not prepared to enter into any arrangements with them. The Council agreed to this at once without discussion. There was another proposal to purchase the tramways of the North Metropolitan and London Street Tramways Companies at a total price of £675,000, and to lease the lines back to the companies at a rental of £45,000 with a percentage on the increase of the receipts. This the committee recommended for adoption, and the first of their reasons for doing so is instructive—namely, "that a lease for 14 years is preferable to one for 28 years." In others words, that course is preferred which adds to the power of the Council. There was a discussion of the type with which Spring-gardens has made us familiar, and ultimately the matter was referred back to the committee. The views of those people who object to tramways altogether as cutting up the streets are intelligible. They are old-fashioned, that is all, but in their way logical. But when you have got tramways, it seems absurd not to have the best ones possible. As Lord Mountmorres remarked in the course of the debate, the horse-traction system is getting entirely out of date, and it would be a lamentable pity if any course was adopted which would prevent London from being provided with a tramway service as efficient as can be found amongst the other great cities of the world.

Lighthouses.—Mr. J. R. Wigham has written to the *Times* to suggest that the loss of the "Drummond Castle" was due to the Ushant lighthouse being an electrically lighted one. It is, in fact, one of the most powerful electric lights on the coasts of France, or, for the matter of that, in the world. As it is asked that the Board of Trade and the Trinity House should reconsider their position and come to a decision not to permit any more electric lights for lighthouse purposes to be erected, it may be worth while to remark that whatever views may be put forward as to the "fog-piercing" power of the electric light, the loss of the "Drummond" has nothing to do with the point. Where precisely that unfortunate ship met her doom is not known, for the wreck cannot be found, and the three survivors could have no means of telling; but all the evidence goes to show that it was not near the Ushant light, but on the other side of the island altogether, and in the channel between it and the mainland. The Currie Company, in confessing that they have been unable to find where the "Drummond Castle" was wrecked, add that they have been distinctly informed that the siren on Ushant was not sounding at the time, from which it may be inferred that on the lighthouse side there was no fog or haze, though, of course, there might very well be in the channel. The really curious thing is that if the "Drummond Castle" took the wrong course she is supposed to have done, she ought to have passed on her starboard side one, if not two, lights, which—writing without references—it is believed are not electric. Any or all of these would, of course, be distinguishable from each other by their flash. The Ushant light is not a mere warning to keep off, but as soon as it is picked up in crossing the Bay it is known

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exactly where the ship is and the proper course. For long-distance work of this character there is admittedly nothing like the arc. And with every deference to the advocates of the Wigham gas lighthouse, no light at all is much good in a fog.

Absolute Measurement of Resistance.—The following description is from the *Times*: Under the direction of Prof. Viriamu Jones, of University College, Cardiff, who has been working at the subject for some years, Messrs. Nalder and Co., of Clerkenwell, have just constructed a machine on the Lorenz method for the M'Gill University which will give a unit of electrical resistance conditioned only by the units of length and time and the properties of the ether. The principle upon which this machine depends is that in a metal disc rotating in the field of force produced by a coil of wire in which electricity is flowing, a current is set up between centre and circumference which varies strictly as the rate of rotation. The resistance to be measured is put in circuit with the coil and a current sent along it, while at the same time the induced current from the disc is sent through the resistance, but in the opposite direction. By varying the rate of the disc a speed is found at which the two opposing currents neutralise each other, and the product of this speed into the coefficient of mutual induction between the coil and disc is the resistance in absolute units. This coefficient can be exactly calculated if the dimensions of the coil and disc are exactly known. In the present machine the utmost precautions have been taken to make every portion perfectly true. The coil, which consists of 200 turns of specially-drawn bare copper wire wound in a screw-thread cut with microscopical accuracy, is carried on a marble cylinder 21in. in diameter, which deviates from the circular by less than two parts in 100,000. The current is taken off the disc, which is very carefully centred, by four brushes through which a constant stream of mercury passes in order to ensure perfect electrical continuity. The bearings are fitted very exactly, and are lubricated by a small pump supplying oil at considerable pressure. Elaborate devices are also provided for adjusting and measuring the speed. The machine is expected to give results accurate to at least one part in 10,000.

The Edison Fluorescent Lamp.—Mr. Edison's new lamp is the subject of a short description in the New York *Electrical Engineer*. It appears that the fluorescent substance as to which Mr. Edison would only say at first that it was easily obtainable, is tungstate of calcium after all. This is fused on the interior of a Crookes vacuum tube, and fluoresces when the discharge passes. "Mr. Edison has found that such a tube shows an entire absence of X-rays externally, and, what is more, no rise in temperature can be detected with a clinical thermometer." The latter seems a curious instrument to use to measure the temperature of a glass tube, or even the radiation from it, but upon this evidence it appears to be concluded that the "entire energy of the X-rays is absorbed by the fluorescent material which emits light." Mr. Edison has also noted that when employed as fluorescent bodies within the tube, instead of outside, as usually employed, some substances develop a higher degree of fluorescence even than tungstate of calcium. It is a very old discovery of Mr. Crookes's that the behaviour of fluorescing substances in a vacuum tube is altogether different to what can take place outside. For the rest it will be better to reproduce the actual words of our contemporary: "As regards the efficiency of the new lamp, Mr. Edison has made preliminary measurements which seem to indicate a very high economy. Thus, measurements were taken on a lamp which Mr. Edison estimated to be of about 1 c.p. The measurement was made by placing a Kennelly direct-current ammeter and a Weston direct-current voltmeter in the circuit feeding the primary of the induction coil connected to the lamp. The ammeter showed an average of two amperes, and the voltmeter 0·3 volt, which would indicate a consumption of 0·6 watt for the lamp of estimated 1 c.p. This result is so remarkable that Mr. Edison himself has doubts as to the accuracy of the indications of the instruments, in view of the peculiar nature of the interrupted current obtained in connection with the induction coil. The current in Mr. Edison's experiments is interrupted over 14,000 times per minute. Mr. Edison proposes during the present week to carry out a complete series of accurate photometric and electrical tests with instruments and in a manner which will not be open to question as to their reliability." A process-block illustration is given of the new fluorescent lamp "as it appears in Mr. Edison's laboratory." The photograph was taken by the light of the lamp itself, with an exposure of about 30 seconds. In the engraving where the lamp should be there is a mere nebulous glow, and the rest of the block is an unflattering portrait of Mr. Edison. The photograph and exposure, however, show that the light of the new lamp must contain a very large proportion of what used to be called actinic rays.

Fluorescence Visible and Invisible.—There has been some discussion in the Société Française de Physique on the subject of the nature of fluorescence, and particularly that produced by the Röntgen radiations. The subject is one which has at present only a purely scientific interest, and it is therefore left to those who are willing and able to spend time on the researches necessary to complete the theory of light and enable a rational account to be given of the new phenomena. But in view of the possibility of a fluorescent lamp being the ultimate result of the vacuum tube experiments now being made in the United States and elsewhere, the whole subject may any day become one of great practical importance. It has been known for some time that uranium salts and metallic uranium itself under the action of ordinary light emit radiations which are invisible to the eye, but can be reflected and refracted to a certain extent, while so far as concerns their action on a photographic plate and their power of passing through substances which are opaque to ordinary light, they resemble the Röntgen radiations. Most of the work in this direction has been done by Mr. Becquerel, but other investigators have obtained somewhat similar results with other substances, though the effect is not nearly so enduring as with uranium salts. Now, in general, in the process of fluorescence the radiations given off are of greater length than those received by the fluorescing substance, and Stokes's law, as it is called, is the expression of the theoretical reason why on the whole it should be so. But if the hypothesis is correct that the Röntgen rays and the uranium radiations belong to the region beyond the ultra-violet, we have apparently a direct contradiction of this, and what looks like a case in which the wave-length is shortened, which, of course, is just what is wanted to be done in order to utilise the energy wasted in producing invisible "heat" waves in almost every known form of artificial illumination. But at the Société it was pointed out by Mr. Guillaume that if a sufficiently complicated structure was assumed it was not theoretically necessary that there should be a degradation of all the wave-lengths, provided that the average length was lowered. It was therefore not impossible that a part of the emitted rays might have a shorter wave-length than the primitive radiation, provided that there was at the same time a sufficient amount of radiations of greatly increased wave-length. The subject

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is one of great difficulty both from a theoretical and an experimental point of view. Indeed, owing to the non homogeneous character of the radiations, and the impossibility of sifting them out, so to say, no two observers seem to get exactly the same results. But it seems at least probable that the theoretical difficulties which have been believed to block the way to an efficient fluorescence lamp do not really exist. Whether anything practical will be effected in this direction time will show.

Royal Institution.—There was a large audience to hear what Mr. T. C. Martin had to say about Niagara at the extra evening discourse which was arranged for last Friday. Lord Kelvin, who had come straight back from the jubilee celebrations at Glasgow, took the chair, and his entrance into the lecture theatre was the occasion of something like a demonstration from the audience in his honour. Among others present were Lord Rayleigh, Prof. Ayrton, Sir Frederick Bramwell, Sir Douglas Galton, M. Moissan, Sir W. Farrer, Sir W. Priestley, Sir F. Abel, Sir B. Baker, Lord Windsor, Earl Percy, and Sir J. Lister, Prof. Dewar, Mr. Alexander Siemens, Mr. Webb, Prof. Silvanus Thompson, etc. After a discourse there is usually something worth looking at in the library of the institution. On this occasion there was a telautograph transmitting written messages. Instead of sending the message as far off as possible, the distance was only to the next table, so that visitors could compare the written and received messages as they were produced. The instrument was, it is believed, shown in the same place some time last year. It did its work very nicely. What appears to stand in the way of its coming into extensive use is that at present four wires are required, which makes the line come expensive. In one of the windows the white flame of acetylene made itself sufficiently prominent; in another window recess was the Ayrton and Mather magnetic tester referred to in these columns last week. Next to this was an apparatus for indicating the magnetic field. An exploring coil is mounted in a handle containing a spring, which on touching a trigger rotates the coil rapidly through an angle of 180deg. The result is read on a ballistic galvanometer. The peculiar fascination of this instrument was that anybody coming along could set the coil, touch it off, see the needle swing, and think he had done something without troubling himself to consider exactly what was required to get accurate results. It was of course explained to anyone who appreciated these matters. In a corner protected from the light by curtains were Messrs. Siemens Bros.' facsimiles of early vacuum work instruments. As long ago as 1785 Morgan, by long continued boiling of the mercury in the barometer tube, produced a Torricellian vacuum of such excellence that no electric discharge that could be produced by the frictional machines, which were the only instruments available in those days, could be got to pass. Beside this was a series of four tubes designed by Dr. Eugene Obach showing the character of the electric discharge at different degrees of exhaustion. The pressures in the tubes were 70mm., 6mm., 2mm., and 0mm. (or as near as can be got to it) respectively. It was very curious to note the complete change in the character of the discharge between the pressures of 6mm. and 2mm., and also the variation in the striations in the high-vacuum tubes under the influence of a magnet.

Mr. Martin on Niagara.—An extra Friday evening discourse was given at the Royal Institution last week by Mr. Thomas C. Martin, who has come over from New York as American delegate to the Kelvin jubilee celebration. The subject of Mr. Martin's discourse was the utilisation of Niagara and the work that had been done by the Niagara Falls Power Company. This was illustrated with a very large number of lantern slides, some of which were very beautiful. As much of the discourse took the form of comment on these, a detailed report of it would hardly do justice to the lecturer, and as regards the actual facts given would necessarily contain much that would be practically a repetition of what has already appeared at one time or another in these columns. Mr. Martin is, of course, well known in connection with one of the first electrical journals in the United States, but as a speaker he is entirely new — at any rate at the Royal Institution. At times his way of putting things very much took the fancy of his audience. Opening with the remark that it was curious that almost alone among the physical features of the Western world the greatest of them should have formed the scene of no notable work of poetry or fiction, and have even failed to receive adequate treatment from the artist's brush, Mr. Martin said that Niagara had remained unpictured, unhistoried, and unsung—with one exception, the excursion literature of the New York Central Railroad. After referring to the 164ft. fall which could be utilised, and the various estimates of the amount of water passing over, Mr. Martin said this varied very much indeed, and consequently the height of the river above and below the falls alters very considerably. Last spring, owing to ice and strong winds, he had seen the falls almost dry. If this is the case, it is obvious that the varying estimates, afterwards alluded to, which have been made as to the total energy of the falls are easily accounted for. After a reference to some of the extraordinary schemes proposed for utilising the power of the falls, Mr. Martin said that Mr. Evershed had suggested that, unlike most water powers, they should have a short canal and a long tail-race, and with the modification involved in the use of electricity this had been adopted. The effect was that there was absolutely no injury to the natural beauties of the neighbourhood. The intake was far above the falls, and the outflow from the tail-race tunnel was underneath a suspension bridge. Nothing, in fact, was visible from the falls. On the other hand, the ordinary practice of a long canal and a short tail-race brought all the mills in a cluster to the edge of the river, and some of the American mills were not pretty objects. Of course, these sort of things sound much better in a lecture-hall than they read in print when separated from their context; but some of Mr. Martin's remarks insist on sticking in the memory. His description, for instance, of the ordinary switchboard as something like an exaggerated street-door with an absurdly unnecessary number of knobs, knockers, and handles appeals to every visitor to a generating station. As to the electric railway in the gorge below the falls, which in places is bracketed out from the cliff over the water, he refused to state how the passengers were saved when the cars ran off the rail, but could strongly recommend a ride on it as giving altogether the biggest shillingsworth of thrill to be obtained anywhere. That was on the American side; the Canadians ran their railway along the top of the cliff in a more Canadian or, perhaps, a more English manner. After engaging the attention of the audience in a calculation showing that the current produced at Niagara could be carried 350 miles to Albany to compete there successfully with coal at 12s. 6d. per ton, Mr. Martin mildly remarked, "But I consider these figures extremely hypothetical." The gem of the evening, however, was unintentional. Mr. Martin inadvertently substituted miles for feet in giving the height of a mountain, but as soon as the applause of his audience showed him what had happened, immediately explained it as the effect of the American habit of exaggeration getting the mastery of him.

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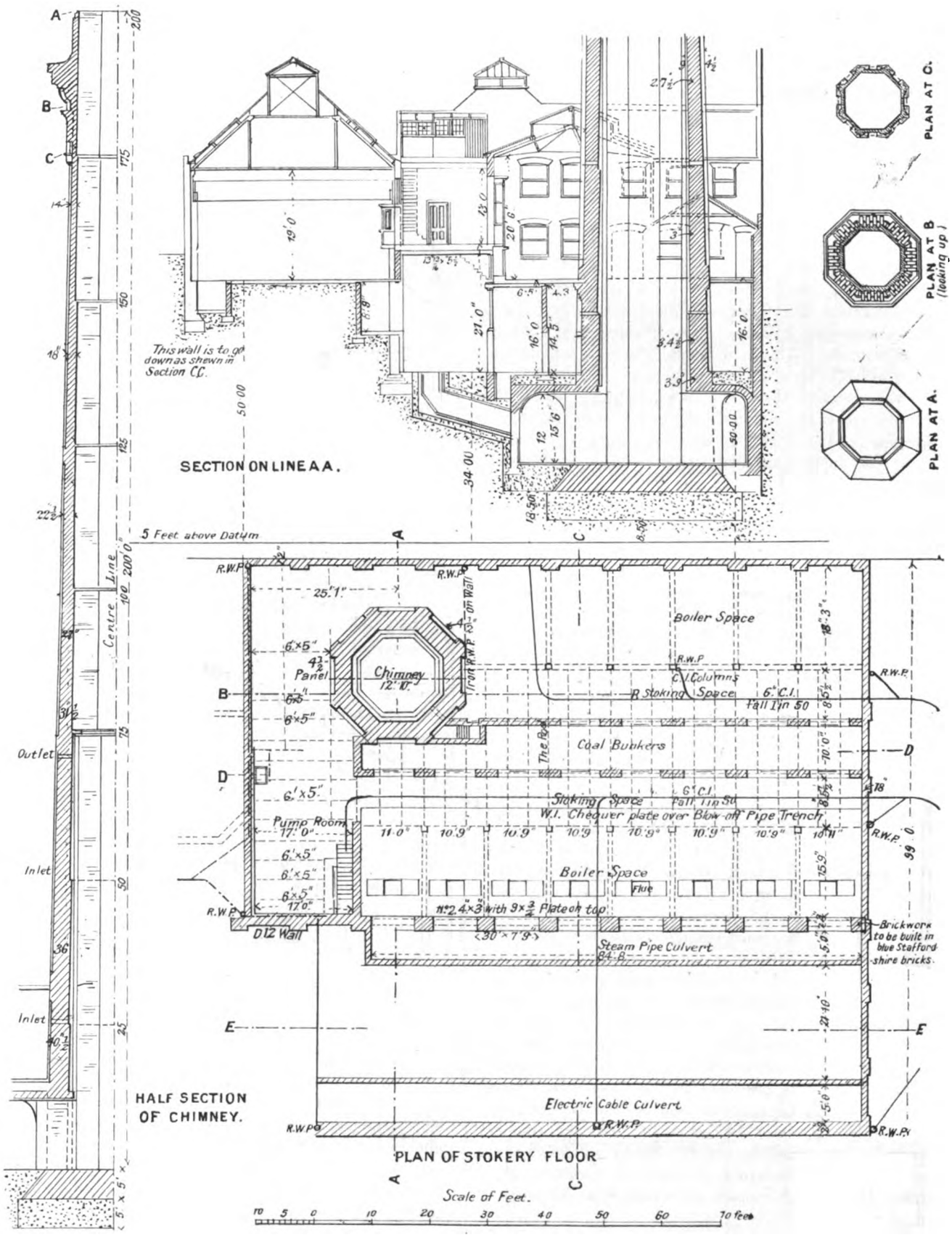
BRIGHTON CENTRAL STATION EXTENSION.

Herewith we illustrate the buildings of the Brighton station, which have been designed by Mr. F. J. C. May, M.I.C.E., the borough engineer. The illustrations explain themselves, and it will be almost needless to point out that all the arrangements have been made for easy and economical working that the long experience gained at this station has shown necessary.



Details of Extensions at Brighton Electricity Works.

HARTLEPOOL ELECTRIC TRAMWAYS.

The following details in connection with the Hartlepool electric tramways have been given us by the Electric Construction Company, Limited, who carried out the equipment of the line on behalf of the General Electric Tramways Company, Limited. The inspection for the Board of Trade was made by Major Cardew and Colonel Yorke on May 14, and the line was opened for public service on May 19.

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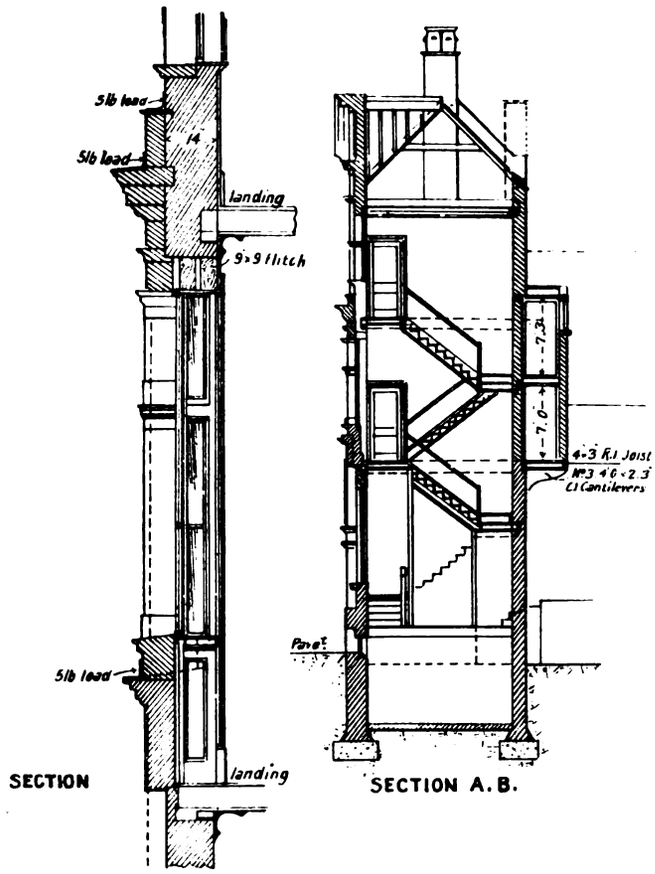

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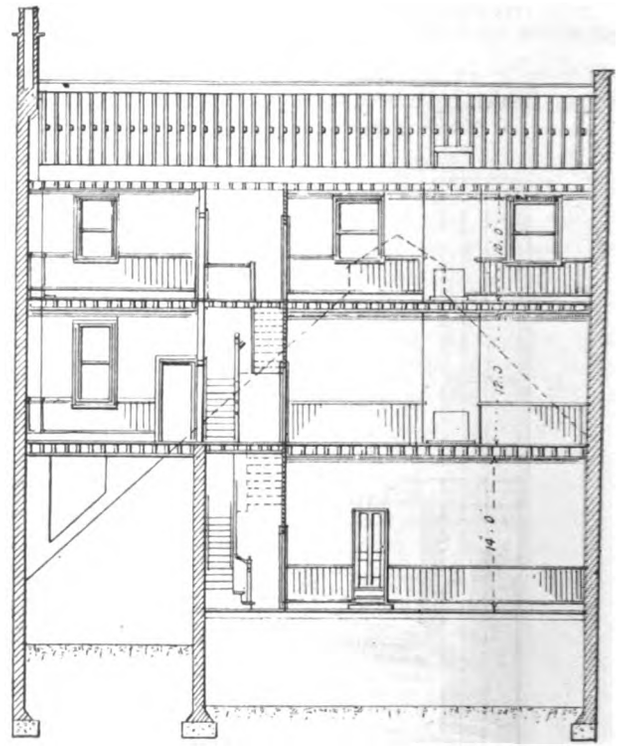
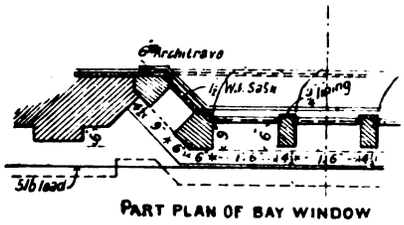
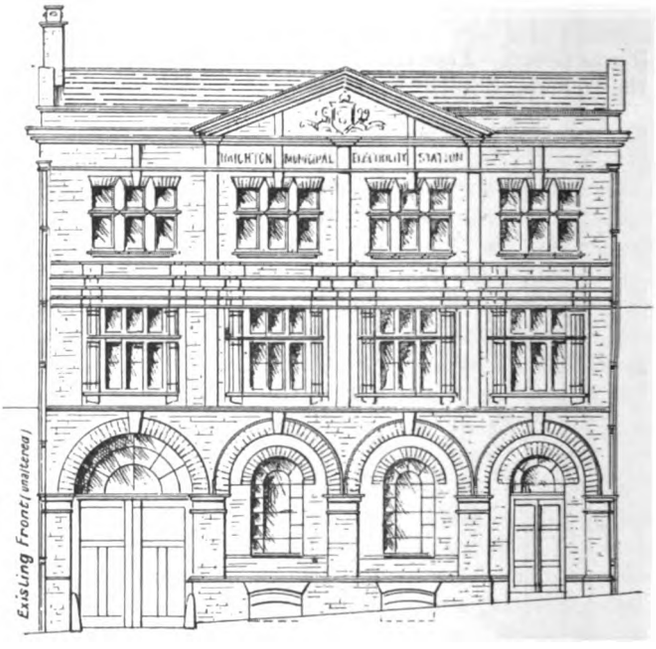
SECTION A.B.



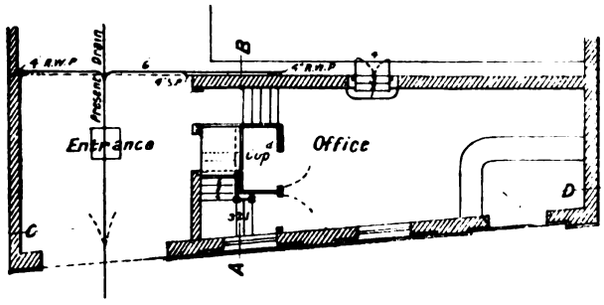
SECTION C.D.



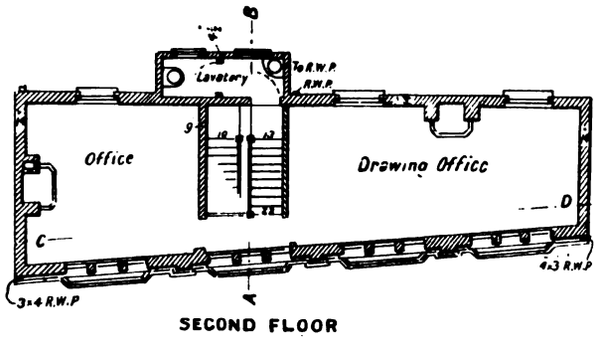
PART PLAN OF BAY WINDOW



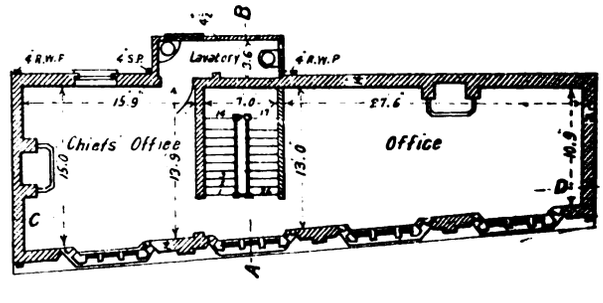
ELEVATION



GROUND FLOOR



SECOND FLOOR



FIRST FLOOR

Scale of feet

10 5 0 10 20 30 40 50 60 70 ft.

Details of Extensions at Brighton Electricity Works.

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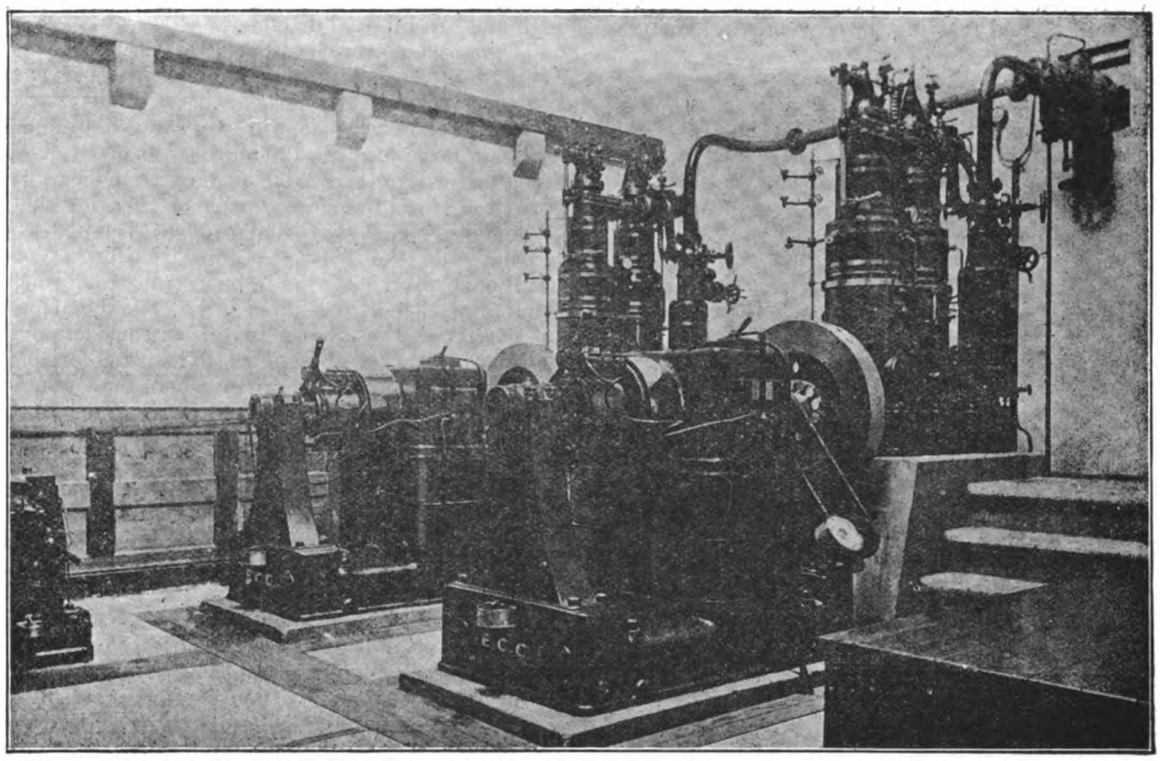
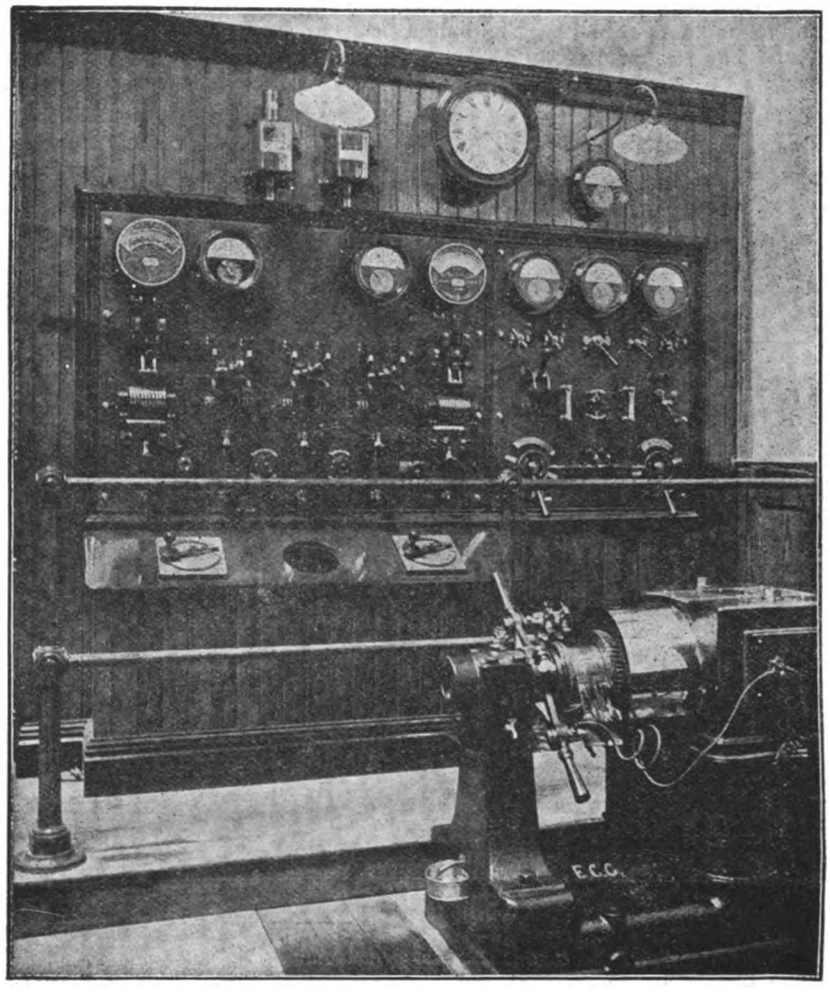
The original tramline dates from 1884, and was worked by steam until 1891, when, falling into a derelict condition, from Northgate-street, in the old town of Hartlepool, to Church-street, in the new town of West Hartlepool, both



Direct-Coupled Engines and Dynamos at Hartlepool.

it was closed. The rights were acquired early in 1895 by the General Electric Tramways Company for the purpose ends extending a little beyond the North-Eastern Railway Company's stations. At present, however, the cars do not



View of Switchboard at Hartlepool.

of equipment on the overhead system. The total length of the line is 2½ miles. It joins the two Hartlepools, stretching run at the West Hartlepool end beyond the Municipal Buildings (about 500 yards short of the full length), per-

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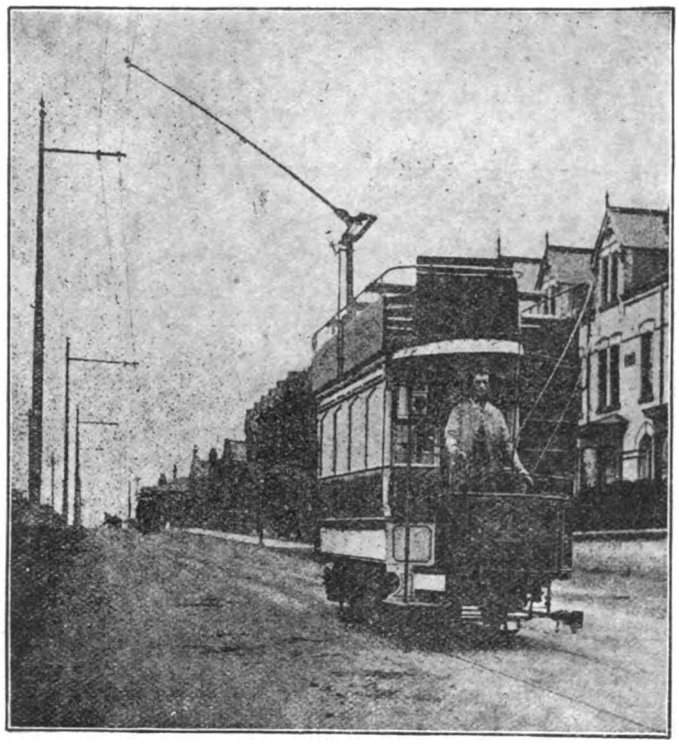
mission not having yet been obtained for the erection of posts on the remaining portion of the line. The entire roadway has been repaired by lifting the rails, rebedding them on concrete, and relaying the pavement. There is a single track with 16 turn-outs. It follows the centre of the roadway, and is laid with 65lb. girder rails. The gauge is 3ft. 6in., and the maximum gradient is 1 in 40, the minimum radius of curve being 40ft. The generating station is almost equidistant from the ends.

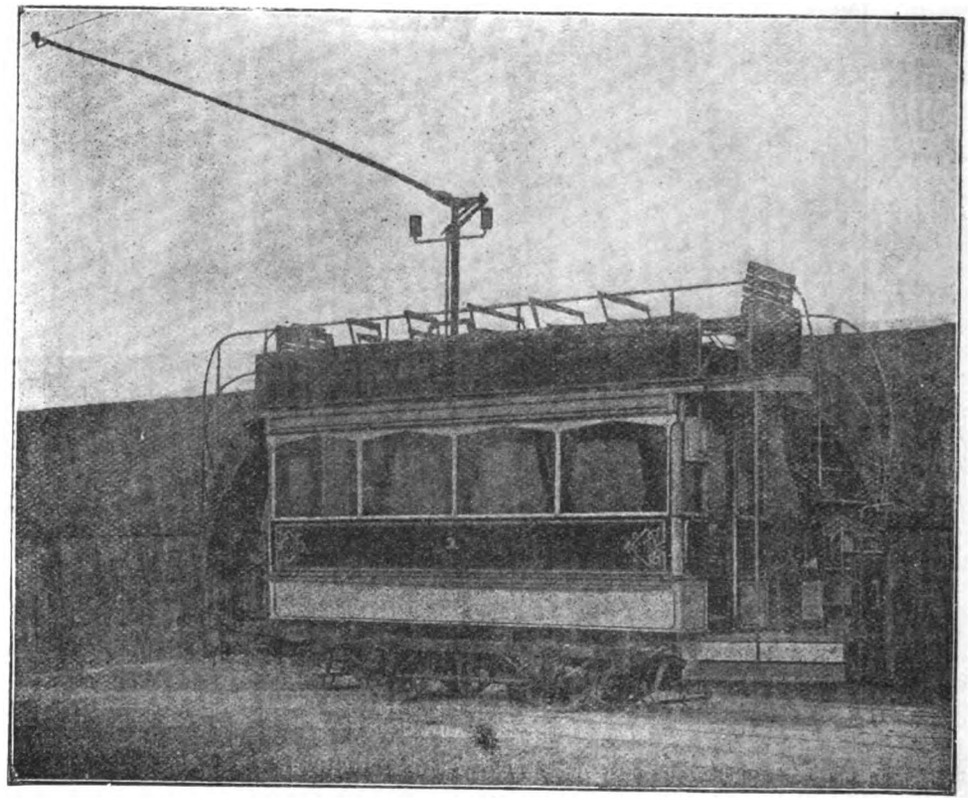


View of Car on Hartlepool Tramways, showing Connection with Trolley Wires.

Generating Plant.—The boilers are in duplicate, of the Galloway type, and were manufactured by Messrs. Galloway, of Manchester. They are 20ft. long and 6ft. in diameter, are capable of evaporating 3,400lb. of water per hour, and work at 140lb. pressure. They are fed by an electrically-driven three-throw feed-pump, 6in. stroke, 2in. diameter, which, at 65 revolutions per minute, is capable of delivering 700 gallons of water per hour. The chimney is 100ft. high and 6ft. internal diameter.

The motive power consists of two G.G.S. Willans engines of 100 i.h.p., running at 450 revolutions per minute and provided with an automatic cut-off. The dynamos—of which there are two—are directly coupled to the engines. Their normal output is 120 amperes at 500 volts, but they are designed to carry 50 per cent. momentary excess current, and are therefore capable of checking the speed of the engine. They have independent bed-plates and two bearings and the shafts are coupled by bolts bushed with hard indiarubber enclosed in brass tubes to deaden concussions transmitted from the engine. The dynamos being of the over type, the engines have been considerably elevated in order to bring the bearings into line, and for this purpose the floor at the end of the room where the engines stand is raised 3ft. 3in. above the ground level. The armatures are wound on the Eickemeyer system, and the magnets are compounded. Copper brushes are used, and the commutators run sparkless at all loads. The commercial efficiency of the dynamos is 93 per cent., and the efficiency of the combined set about 84 per cent. One engine and dynamo suffice for the service of four cars, the second set being in reserve. Provision is made for third set should a heavier service be demanded.

An interesting feature in the general arrangement is the provision of an auxiliary plant, consisting of a secondary battery and dynamotor driven from the generating dynamos. The cells are charged simultaneously with the working of the line whilst the load is light, but at moments of excessive demand the direction of the current is reversed, so that they supplement the current supplied to the cars by the generating dynamos, thus rendering the load less variable, and increasing the working capacity of the system. The arrangement also serves at 100 volts for driving the feed-pump, lighting the station, and moving the cars in the car barn; and as the current from the accumulators is available at all hours, it is possible to run late or early cars when the engines are not at work. The dynamotor is of the improved type now being constructed by the Electric Construction Company, with a double-wound armature for 500 volts 30 amperes and 135 volts 85 amperes. The efficiency of conversion is 85 per cent. It runs at 800 revolutions. The secondary battery consists of 53 E.P.S. 31K cells.



Car on the Hartlepool Electric Tramways.

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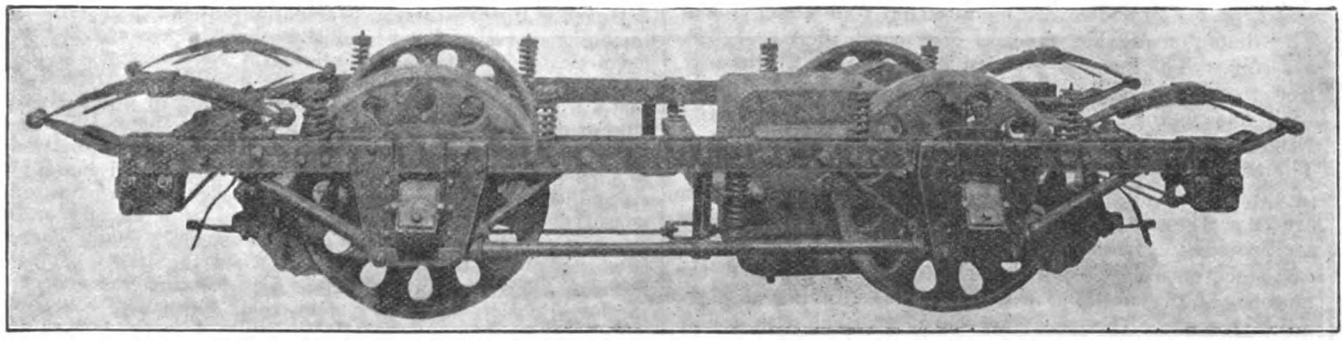
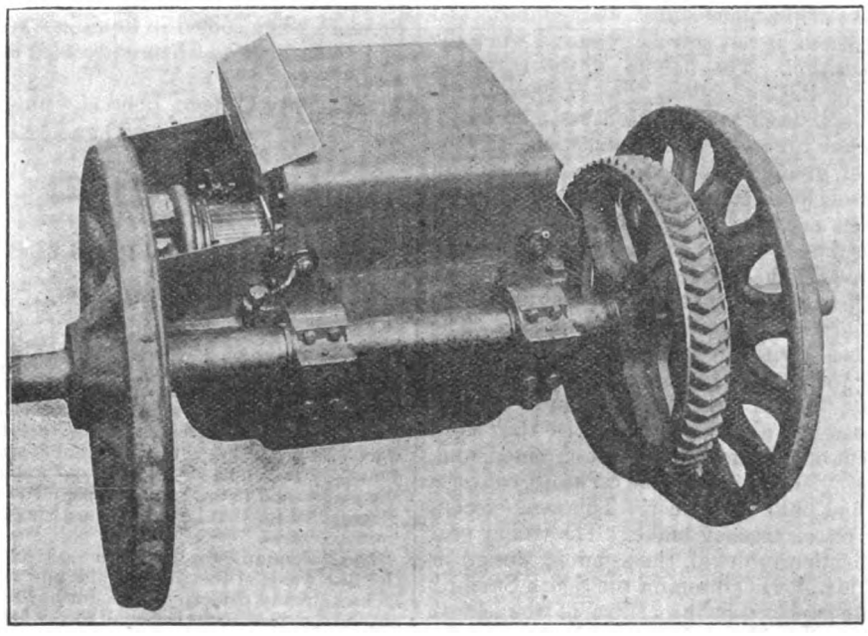
The switchboard stands in the engine-room, and is provided with single-pole automatic cut-out switches for each circuit, and also with single-pole throw-over switches for each dynamo, thus serving to connect them with either of the two circuits into which the line is divided. On the other pole are placed fuses enclosed in glass tubes, with spring connections, enabling them to be instantaneously replaced. Dead-beat Weston ammeters are used on the line circuits and "E.C.C." ammeters on the dynamos. The voltmeters are Kelvin's electrostatic pattern, and suitable switches are provided for the transformers lighting circuits,



Four Wheel Truck on which the Cars are Mounted.

etc., the dynamos being provided with regulating resistances. Across the terminals of the automatic cut-outs are placed resistances to carry 60 amperes. These, when through excess of current the switches open, still permit half the normal current to pass into the line, racing of the engines and dislocation of the traffic due to complete cessation of current from transient causes being thus avoided. The sparking across the switches is, moreover, greatly reduced, and the attendants can with impunity close them to ascertain whether working can be continued or whether permanent short-circuit exists.

Line Equipment.—The general arrangement is the same as on the South Staffordshire Tramways—namely, the side



View of Motor—Hartlepool Electric Tramways.

pole system as originally designed by Mr. A. Dickinson, M.I.C.E., and adopted by the Electric Construction Company. No attempt at ornamentation has been made in the poles, but owing to their position at the side of the road, and the entire absence of span wires, they are wholly free from any unsightliness or from the other grave objections which have been advanced against the introduction of the overhead system in this country. The advantageous position of the station and the moderate length of the line and service render feeders unnecessary, two trolley wires of No. 0 B.W.G. sufficing to carry the current. One of these wires takes the up and the other the down service, and they are cross-connected at two points so as to supplement one another. One circuit takes the line on the side of Hartlepool and the other on the side of West Hartlepool, sectional insulators being placed halfway in either direction, so that in the event of an accident happening to one of the trolley wires, pressure can still be maintained on the other. Two wires also do away with the necessity of any turn-out switches, and simplify the working. The poles are placed on the kerb, 120ft. apart on the straight part of the line but somewhat nearer on the curves. To keep the trolley wire as nearly as possible at a uniform distance from the centre of the track, the length of the arms varies from 4ft. to 12ft. The height of the trolley wire above the line is 21ft., except at two points where bridges on the North-Eastern Railway cross the road, necessitating a reduction to 16ft. It might be thought that the depression of the trolley poles here required would cause trouble in working, but such has not proved to be the case, and there is absolutely no tendency for the trolley wheel to leave the wire at these points. The insulators are of the Ætna type, the wires being clipped in long ears without soldering. The poles were supplied by Messrs. J. Russell and Sons, Limited, of Wednesbury, and are taper steel tubes 29ft. long, 6in. diameter at the ground level, and 2½in. diameter at the arms. At the curves 7in. poles are used, and terminal poles 12in. diameter are provided to take the end strain of the wires. The rails are used as an uninsulated earth return. Electrical continuity between the rail joints is secured by means of duplicate bonds as well as by the fishplates. The bonds consist of No. 4 B.W.G. copper wire wrapped round and soldered to the end of a taper iron stud which is driven hard into a rymered hole in the web of the rail, fixed by means of a nut and washer. The whole is then coated with a tar compound and embedded

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in the roadway. The rails are connected from the points where they pass nearest the generating station to the switchboard by means of an insulated underground $^{19}/_{12}$ B.W.G. cable, 50 yards long, and the line by four $^{19}/_{15}$ cables drawn into iron pipes. A recording voltmeter, a leakage indicator, and earth-plates are provided at the station in accordance with the Board of Trade regulations.

The cars, constructed by Messrs. G. F. Milnes and Co., of Birkenhead, are five in number. They each measure 22ft. over all, and seat 18 passengers inside and 20 outside. The seats in the interior are longitudinal, and on the roof are of the cross garden-seat type. The bodies are mounted on four-wheel trucks. The diameter of the wheel is 33in., and the wheel base 5ft. 6in. The springs give an easy motion to the car, free from oscillation or pitching. Each car is fitted with one motor. The armatures are drum wound with Eickemeyer coils, the cores being slotted and uninsulated. The whole of the insulation being in the coils, replacement of a defective coil is quickly and cheaply effected. There are 72 sections in the commutator, and four carbon brushes are provided. The magnets are two-pole, iron-clad, and of cast steel, entirely closing the armatures. The speed of the motor is 360 revolutions when the car is running at eight miles an hour. The gear wheels are cast steel, with double teeth helical and single reduction. They are cased in and run in oil. The magnets are spring-suspended from the truck. The total weight of one car fully loaded is 7½ tons, and it is found that this requires a current when running on the level of about 12 amperes. The maximum commercial efficiency of the motor is 83 per cent., and for a considerable range of speed it is over 80 per cent. At eight miles an hour 10 h.p. is developed.

Access to the motor can be obtained either from above, by lifting a trap in the car floor, or when the car is standing over the pit in the car barn, by canting the lower half of the magnets and armature on the axle. The controlling gear is in duplicate, one set being placed at each end of the car on the platform underneath the stairs. The driver stands at the foot of the stairs with the regulating wheel in his left hand, and the wheel brake is within easy reach of his right hand. The spindle of the regulating switch projects from the riser of the third stair. Being interlocked with the reversing switch, it can only be removed when the latter is in the off position. The handle of the reversing switch is on the top of the controller. The resistance consists of 40 platinoid spirals sheathed with asbestos and contained in vertical brass tubes. This construction has the double advantage of giving support to the coils, and, in consequence of there being a considerable mass of material, of absorbing a large amount of heat for short periods. The tubes are insulated from one another by being let into slate bases, and the ends of the platinoid wires are led direct to the switch contacts, so that insulated connections are avoided. The switch has 21 points. The movable contact is made with an iron limb, and is wound with a coil carrying the current from the trolley, and thus a travelling magnetic field is created which blows out the arc at every contact. It is also worthy of notice that when the line current is cut off the motor is short-circuited, and, operating the reversing switch before the car stops, converts it into a generator and pulls up the car. This arrangement takes the place of an emergency brake. The trolley gear is, with some modification in detail, the same in design as that introduced by Mr. A. Dickinson on the South Staffordshire Tramways. It is placed in the centre of the length of the cars close to the side, and mounted on a strong wrought-iron plate well secured to the roof. The cars are lighted by six 16-c.p. incandescent lamps, one being placed fore and aft in the ordinary signal lanterns, one at each side of the car inside, and two on the roof, attached to the trolley pillar.

Without presenting any very striking novelty, the Hartlepools line may be taken as a fair sample of what is requisite to popularise electric traction. As it also shows what can be done without detriment either to appearance or to the convenience of ordinary traffic along the same road, it should be a very fair answer to many of the objections that have been urged against the overhead system.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE ELECTRICAL RESISTIVITY OF BISMUTH.

SIR,—A communication was made on Thursday last to the Royal Society by Prof. Dewar and myself in the form of a letter addressed to the president, of which the following is a copy:

The Royal Institution, Albemarle-street,
London, June 1, 1896.

To the President of the Royal Society.

DEAR SIR JOSEPH LISTER,—In continuing our experiments on the electrical resistance of bismuth at low temperatures and in magnetic fields by the aid of a powerful electromagnet kindly lent to us by Sir David Salomons, we have observed the fact that a wire of electrolytic bismuth when cooled in liquid air to a temperature of −186deg. C. has its resistance increased more than 42 times if it is at the same time transversely magnetised in a field of 14,000 units. The bismuth when cooled in liquid air and thus magnetised has its electrical resistance increased more than 15 times, even when compared with its resistance at ordinary temperatures and not in a magnetic field. There is no reason to believe we have reached the limits of this increase. Reserving further details for a full communication to the Royal Society later, we remain, yours very truly,

(Signed) JAMES DEWAR.
J. A. FLEMING.

It may be interesting to give the exact figures of observation for the information of your readers. The wire of electrolytic bismuth had a resistance of 1·46 ohms at 19deg. C. when not in a magnetic field. If placed transversely to the field in a field having a strength of 14,150 C.G.S. units, its resistance was increased to 2·34 ohms at 19deg. C., or 1·6 times This, of course, is a well-known effect. If the same wire, however, was placed in liquid air and cooled to −186deg. C., its resistance fell to ·53 ohm. If then placed transversely to the field in a field of 14,150 units, its resistance immediately increased to 22·4 ohms, or 42·2 times. Hence, the bismuth cooled to −186deg. C. and in the field of 14,150 has a resistance 15·3 times greater than when at 19deg. C. and not in the field. There is a certain value of the field which just neutralises the diminishing effect of the cooling on the bismuth resistance, and leaves the wire when cooled in liquid air and in the field of the same resistance as when not cooled and not in the field.—Yours, etc.,

J. A. FLEMING.

University College, London, June 20, 1896.

LEGAL INTELLIGENCE.

A WIRING CLAIM.

At the Westminster County Court last Wednesday, before his Honour Judge Lumley Smith, Q.C, the case of Taylor *v.* Titmus was heard.

The plaintiff, an electrical engineer, sought to recover payment of a balance of account for supplying electric light to the defendant's offices in Northumberland-avenue.

The plaintiff's case was that he was asked by the defendant to connect his offices with the mains and fix up four lights. The work was proceeded with, and while it was in progress the defendant paid two sums of £3 each on account without making any complaint, and it was not until payment of the balance of £2. 15s. was applied for that he put forward the suggestion that the charges were excessive.

The **Defendant** was called, and said he was under the impression that the whole of the work would not have exceeded £5, and as he had already paid £6 on account he did not consider there was any further liability. On behalf of the defendant's case, a **Member** of the firm of Dodge and Frazer, electricians, of Cecil-court, was called, and said he considered the plaintiff's charges were too high.

His **Honour** gave judgment for the plaintiff.

ELECTRICALLY-WORKED TIMEKEEPERS.

Last Tuesday in the Chancery Division of the High Court of Justice, before Mr. Justice North, the case of Jardine *v* King, Mendham, and Co. was decided.

Mr. Thomas Terrell, Q.C., and Mr. W. P. Rylands appeared for the plaintiff; and Mr. Bousfield, Q.C., and Mr. C. E. E. Jenkins for the defendants.

In this case, the plaintiff, who resides in Demerara, had taken out a patent for an automatic electric workman's timekeeper, and now sought to restrain the defendants, who have a subsequent patent, from infringing his patent. The plaintiff's instrument is

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provided with a slot, in which each workman inserts, when arriving at the works, a ticket or metal disc with a number or name for identification. Within the instrument there is a deflector, which in one position guides any ticket inserted in the slot to one compartment, and in another position guides the ticket into another compartment. An electromagnet operated by a clock turns the deflector at a fixed time, so that the tickets of the workmen who come early go into one compartment and those who come after the appointed time go into the other compartment. In the defendants' apparatus tickets are also used, which are placed in a slot, and can, in the ordinary form of the defendants' instrument, drop either into a locked compartment or be returned to the workmen, according as one or another shutter is open. The opening and closing of the shutters is effected by an electric apparatus operated by a clock at an arranged time.

His **Lordship** considered the defendants' contrivances for effecting an object which was not a new object were not within the plaintiff's patent, and gave judgment for the defendants.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Tuesday at Winchester House, E.C., to consider a recommendation of the directors that the capital of the Company should be increased to £1,000,000 by the creation of 50,000 new shares of £10 each. Sir Eyre M. Shaw, K C.B., presided.

The **Chairman**, in moving the resolution authorising the increase of capital, said shareholders would have been prepared by what he stated at their last meeting for the notice they had recently received. Some months ago their chief engineer, Mr. F. Bayley, had laid before the Board his estimates of the Company's probable requirements up to the year 1900. These estimates referred to the new works which were rendered necessary owing to the satisfactory manner in which the demand for electric lighting was being maintained. That increased demand was not only gratifying in that it was large, but it did not come by fits and starts, but continuously, as if it were obeying some law of demand upon the maintenance of which they could rely with confidence, and which had been the main factor in enabling the Board to make their calculations for the future. In addition to this normal progress, which was practically assured, he might remind them of the reduction in the rates of charge to certain classes of customers. The Board had every reason to believe that this concession would be a great boon to a large number of customers, especially smaller tradespeople, who, owing to the regularity of their lighting hours, could be supplied economically, and to whom they were therefore able to offer their lowest current rates. The increase in their lamp density in many portions of their district also warranted their commencing the work of rearranging their system of supply by the creation of transformer sub-stations. From the very commencement of their working the formation of these sub-stations had been kept in view. Special appliances, such as large transformers and concentric mains, with the necessary connections, were requisite for the work, and it had taken some time to bring their manufacture to the present state of perfection. They could therefore confidently look forward to obtaining the best results with absolute certainty, and with a much smaller capital expenditure than would have been the case had they embarked on this undertaking during its experimental stages. In carrying out this development the directors wished it to be understood that the work which had been done up to the present time had not only fulfilled its purpose of maintaining their supply during what might be termed the pioneering period of the Company's history, but the methods then adopted now enabled them to undertake the new work with the greatest facility and with the complete utilisation of their past expenditure. It would be obvious that to carry out these works on the most economical basis it would be necessary to construct them to meet the demands of the Company as they arose from time to time, and to be in a position to take advantage of the most favourable time for making contracts for new machinery and materials. In asking the shareholders, then, to pass the resolution which authorised the increase of the share capital of the Company for the reasons just given, they asked the shareholders to leave it to the directors to issue the proposed new capital at such times and in such amounts as the exigencies of the Company seemed to demand; and they also asked them to leave to the Board's discretion the best method of placing the various issues on the market. It was only after the fullest consideration, and after consulting with those best able to advise them, that they came to the conclusion that, in the interests of the Company, the capital required could be more advantageously raised by the creation of share capital than by any other method. As to the progress of the Company, so little time had elapsed since he last had the pleasure of meeting the shareholders that he had not much additional information to impart as to their present position. He might say that the revenue for the first quarter of the present year amounted to £38,616, as against £31,201 for the corresponding quarter in 1895, or an increase of 23 per cent. The number of lamps connected, which, on the date of the last report—viz., March 17 last—was 272,000, now amounted to 285,000. Before moving the resolution, he would refer to certain letters which the Board had received. While he was most anxious to assure their original shareholders that the Board fully realised how much was due to them, he felt convinced that they would understand that it would be manifestly inexpedient, even if it were possible, for him to tell them the precise terms on which the first or any subsequent issue of the new capital would be made. The conditions under which these issues would be brought out would quite possibly vary to meet the conditions of the market at the time, and he asked, therefore, those gentlemen who had been kind enough to write to accept his assurance that, so far as it was conveniently possible, the interests of the shareholders of the existing capital of the Company should receive the first and best consideration.

Admiral Lord John Hay seconded the resolution.

Mr. John Newton said he would be the last man to offer criticism against directors who had done so much for the shareholders, he had certain opinions as to the issue of shares by directors at such times and at such prices as they might think proper. Shareholders had certain rights, and, in asking them for power to issue the new shares at such times and at such price as they thought proper, the Board were not showing that confidence in the shareholders which the latter had in the directors. He considered that the new shares ought to be issued to the existing shareholders at par, for, if they had to pay a premium on them, the dividend which would be declared would really be less than it seemed. If, for instance, they paid a premium of £2 for their new shares, a dividend on them of 6 per cent. would really be reduced to 5 per cent., and he maintained that this would be to the advantage neither of the shareholders nor of the Company. Their customers, who would look only to the nominal capital, when they found them paying large dividends on that, would think they were being plundered, and there would be an outcry to buy the Company out or destroy their monopoly. He thought it a wrong policy to spring a new issue on the shareholders. At least, some intimation might be given to the effect that within the next six months an issue would be made so that they should not be taken by surprise.

Mr. Billson asked if the directors had considered the question of getting rid of the founders' shares.

The **Chairman**, in reply, said that if the shares were standing at over par, he did not see any reason why the directors should issue them to the shareholders, or anyone else, at par. They would not be justified in issuing them at par when they knew their value was a great deal more. If Mr. Newton wished for further detailed information on the point he had raised, no doubt the auditor, Mr. Griffiths, would be able to satisfy him. With regard to the founders' shares, there was no means of extinguishing those shares unless they had the consent of the founders themselves and a general meeting.

Mr. Newton said that if the directors issued the shares at a premium they could not call it anything but capital, although it might be entered in the books of the Company as premium. Founders' shares were a curse to any company, and if the directors could not deal with them all he could say was that they were not business men. Those founders' shares had a value, and anything of value in the market could be bought. Under the evil influence of the founders' interests large dividends might be earned and, perhaps, paid, to the danger of the Company. If the premium on the new shares were to be used in getting rid of the founders' shares, the question he had raised would be of less importance; but if they began to pay a dividend in excess of 7 per cent., after taking a large premium on new issue of shares, they would raise the question—a fundamental one—as to the respective rights of the holders of the founders' shares and of the ordinary shares.

The **Chairman** pointed out that there was no obligation on the shareholders to take the new shares.

Mr. Newton replied that that was no answer to the point he had called attention to.

Mr. John G. Griffiths (Deloitte, Dever, Griffiths, and Co., auditors of the Company) said Mr. Newton had raised an objection to a course of procedure which was almost universal. If the directors had thought it right to recommend the issue of debentures, debenture stock, preferential stock, or anything which would bear an interest charge in priority to the shareholders' rights, the same result which Mr. Newton regarded as so improper would follow—namely, they would improve the dividends upon the stock of the Company and raise its character as an investment before the public. So far as he might express an opinion in the matter, he would suggest that the price of issue should be such as, while bearing a moderate premium, would tempt the existing shareholders to take up their allotment. But there were shareholders whose means would not permit them to buy that stock however much they might desire to have it, and that being the case he trusted the price of issue would be such that they could sell their right to the allotment of new stock at a moderate profit. To issue the stock at par was practically giving away a large amount of the goodwill which the business of the Company had produced. That premium should go to the credit of the capital account. He thought it would be downright improper, although perhaps not illegal, to put such a premium to the credit of the profit and loss account. It should go to the capital account, and be used as capital for the purposes of the Company.

Mr. Newton said he was not convinced by what had been said, and he desired to move an amendment recommending the directors to issue the proposed new shares at par to existing shareholders.

Mr. Mullett seconded this amendment.

The **Chairman** said he could not accept such an amendment, as it would be out of order, and the resolution was put to the meeting and declared carried, with one dissentient.

Mr. Newton said he would bring the matter forward again.

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THE

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ELECTRICITY AT BRIGHTON.

It is but two short weeks ago that the Municipal Electrical Engineers visited Brighton; last week it was the turn of the Borough Treasurers; this week there is a large gathering of Municipal Engineers, whose president is Mr. F. J. C. May, the borough engineer. Surely it cannot be altogether that the Brighton air is so terribly attractive, but more probable that the Corporation possesses able officials whose knowledge and experience is needed by colleagues in their respective associations. We, knowing well these officials both at Brighton and Hove, feel pretty certain that the latter suggestion is the correct one. In these columns we have to deal specially with electrical work, and it is very well known that Brighton was one of the first of the seaside towns to patronise the electric light—in the early days under a company, now under the control of the Corporation. The work has been successful, and large extensions have just been carried out from the designs of Mr. May so far as the buildings, etc., are concerned, and Mr. Wright so far as the machinery is concerned. When, added to the Brighton work, we find that Hove is also provided with a central station, it is not difficult to realise that the householders are real patrons and not pretenders. But Brighton has a further claim to our consideration, in that here Mr. Volk, in 1883, laid down the first electric tramway, which has continued running except during periods of repair or relaying the line. Further, one of the coming attractions is another electric tramway to run between Paston-place groyne and Rottingdean, a distance of nearly three miles. This line is somewhat unique, in that the rails will usually be below the surface of the sea—in some places at high tide the rail level will be fifteen feet below water-level. In our issue of November 8 last we gave some details, with illustrations, of this line. To-day the engineer of the line, Mr. R. St. George Moore, M.I.C.E., will read a paper on the subject of "Electric Traction" to the Municipal Engineers, and in this paper he gives a brief description of the line. There are two or three points in this short paper which may be deemed important. One from an economical point of view may be taken first. At the end of the nineteenth century this country is thickly populated and dependent upon foreign lands for most of its foodstuffs. According to Mr. Moore, "the horses in London would alone consume more than the produce of a million acres of ground." Suppose, then, some form of mechanical motor took the place of the horses, the produce of this million acres might otherwise be utilised. Possibly, instead of feeding horses, it might feed cattle or sheep, and so reduce the importation of meat stuff from other countries. The problem is a big one, but it has another side. This is pleasant to look upon, and may be deemed satisfactory; the other is less satisfactory. If we are to replace horseflesh by means of steam, gas, or electric motors, we shall increase the demand upon our coal supplies. Five-and-twenty years ago alarmists prophesied that the end of the century might possibly see the inhabitants of these islands at their wits' ends for coal.

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Well, the population has grown, the manufacturing industries have grown, steam locomotion has grown, and the coal supply is not deemed near exhaustion. Certainly the demand has not increased in the ratio of the steam power used, because engines are far more economical than they were, and a horse-power hour is produced with a far less destruction of coal than was thought possible in years gone by. Still, to replace the energy of millions of acres of land is a big request. This side of the question, then, will have to be considered, but we do not think designers and inventors should stop work because of it. Babylon is a howling waste just now, and England may become merely an agricultural and residential property in years to come, but that is no reason why we of the present time should stop the wheels of progress. If the coal stores are exhausted, and we cannot replace that coal nor find any substitute, why then the surplus population must emigrate. Someone might well ask if the million acres are not enough to more than obtain the mechanical motors required to replace the horses. If this question could be correctly answered in the affirmative, then the coal problem might be shelved or solved. Thus Mr. Moore brings us face to face with the question, Will a piece of land of sufficient size to keep a horse produce something else which, if turned into mechanical energy, will replace or more than replace the energy obtainable from the horse? Lastly, for the present some means may be found to obtain more nearly the theoretic energy of the coal than is at present obtainable by means of a steam-engine. Various towns are considering the question of traction, and no doubt will carefully consider the points brought out in Mr. Moore's paper. The London County Council is just considering a memorandum (given elsewhere) of one of its members upon the subject; and though progress may be slow, it seems pretty sure.

ELECTRIC TRACTION FOR TRAMWAYS.

Mr. J. Allen Baker, L.C.C., who is a member of the Highways Committee of that body and of a well-known firm of London engineers, circulated amongst his colleagues a few days ago the following important memorandum detailing the growth, cost, and necessity of electric traction for tramways. An amendment based upon this memorandum was passed by the Council on Tuesday last in preference to the report of the committee:

As a member of the Highways Committee, and taking a deep interest in the subject of the London tramways, I venture under a sense of duty (but not without some hesitation, as a new member of the Council) to present a few facts before my fellow-councillors for their consideration.

Ever since the proposals of the syndicate and of the North Metropolitan Tramway Company have been before the Highways Committee, I have felt how entirely inadequate was either offer to compensate the London ratepayer for his valuable tramway property, and as a natural consequence have consistently opposed in committee the proposals now submitted to the Council.

I urged my committee, before sending forward their report, to make an exhaustive investigation of all the improved systems of electrical and other methods of tramway traction in use on the Continent of Europe and in America, so that we might form an estimate of what our tramways would be likely to produce in the next 14 years if the most suitable of these improvements were adopted, and also what advantages would be given to the public who used the tramway system.

I have felt that our duty is twofold: (1) to obtain the best possible profit for the ratepayers; (2) to obtain the system that will give the greatest satisfaction to the travelling public.

Having visited the principal cities in Canada and the United States during the past few years (including the Pacific coast), and observing the great advance that has been made in the tramway service there, as well as on the Continent of Europe, I have felt that I should not be clear of my own personal duty and responsibility if I did not place before you some of the latest information upon the subject, which I have been able during the past few weeks to obtain.

I append the following figures, which will give the total mileage of electric and other mechanical traction on the Continent of Europe and under construction on January 1, 1896.

	Running January 1.	Under construction January 1.	Total mileage probably now running.
	Miles.	Miles.	Miles.
Germany	245 30	201 73	447·03
France	78·37	38 00	116·37
Italy	24·61	57 00	81·61
England	36·38	13·53	49·91
Austria	44·04	—	44·04
Switzerland	25·24	4·80	30·04
Spain	17·99	11·18	29·17
Algiers	—	22 00	22 00
Belgium	15·45	—	15·45
Norway	4·66	3·10	7·76
Russia	6 20	—	6·20
Servia	6·21	—	6·21
Bosnia	3·47	—	3·47
Roumania	3·37	—	3 37
Holland	1 98	—	1 98
Portugal	1 73	—	1·73
	515 00	351·34	866·34

By the foregoing it will be seen that England is far behind Germany, France, and Italy in the adoption of the recent improvements in tramway traction, and London, which has greater need, and probably greater chances of success than any other city in the world, does not possess a single mile.

Of the 866 miles of electric tramway in Europe, over half is in Germany alone, and it is in this country, after thorough trial and proof of economy, that the most rapid extension is going on.

The example of the United States and Canada is still more striking. Eight or nine months ago it was stated that there were 10,000 miles of electric tramway in operation in North America. It is now estimated at upwards of 15,000 miles.

Hanover has a greater mileage of tramways in proportion to its population than any other city on the Continent. The present tramway company bought up the original three years ago—then paying 1½ per cent.—and now, with 15 miles of electric lines, started 18 months ago, and 34 miles of horse traction, is paying 4 per cent.; and so successful has the electric installation been that all the remaining horse lines are to be converted to the electric system next year.

Hamburg is the first city in Europe to have the whole of its tramways converted to electric traction. It formerly employed 2,600 horses. Many of the streets where the trams run are narrower than those in London and quite as busy. This is the largest installation in Europe, and has been a marked success.

Berlin.—Two test lines are being converted and equipped for electric traction, and it is fully expected that very soon electric traction will supersede horses over the whole 125 miles of the tramway system. The system to be adopted is the overhead and conduit combined.

Milan has a very successfully-combined electric light and electric tramway system. The Corporation decides what routes are to be run and how many cars, also fixing the fares. The charge is 1d. all the way out from the centre, and the company are bound to run special cars one hour each morning and one hour each evening at a fare of ½d.

Paris.—Several systems of mechanical traction are in use in Paris on certain routes, but seeing that the com-

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pany's leases do not expire till 1907, desirable improvements are not likely to be brought about for some time.

Rouen.—The tramways of Rouen have just been transformed from horse to electric traction, the opening of the latest line being on March 22, 1896. The frequency of the service in 1895 with horse traction was such that two round trips per hour per car were made; whereas in 1896 with electric traction three round trips per hour per car were accomplished. From February 8, 1895, to March 19, 1895, the receipts from horse-car service, *with* 30 *cars* in operation, *amounted to* £2,000; and for the same period in 1896, *with* 32 *electric cars*, the receipts amounted to £3,800. During the period dealt with in these comparisons no change in the fares had been made, the first-class fare being 1½d., and the second-class fare 1d.

These figures show in a striking manner that traffic increases with the adoption of electric traction, on account of it being so much quicker and more attractive and popular.

It is not surprising therefore that a deputation of the Glasgow Corporation, which has recently visited the principal cities on the Continent to inspect their tramway systems, should say: "Our general observation is to the effect that a practically universal move in the direction of substituting electric power for horses is in progress all over the Continent," and should recommend their own Corporation to adopt the most approved electrical system, and this, notwithstanding the fact that it is but a little more than a year since the same Corporation completely installed their own tramway system with new cars and horses.

Nor is it surprising that the enterprising Corporation of Birmingham, after making trial of two other modes of mechanical traction, should decide upon an electric system for their city, the contract for which, I believe, has now been entered into.

Mr. W. H. Preece, C.B., F.R.S., vice-president of the Society of Arts, in speaking of the development of the electrical traction in the United States (see *Journal* of the Society of Arts, March 20, 1896) states: "If the tramway company worked its system by electricity instead of horses, the result would be that *it would cost them about* 1½*d. per mile, instead of* 4*d. for horsepower* . . . He heard that the growth of traffic in Bristol since the introduction of electricity had been very satisfactory, and the same thing had been noticed in America. On the same roads, with the same cars, what was called the factor of public satisfaction, arising from the quicker rate of travelling and other improvements, had increased the amount of traffic by some 30 per cent."

Mr. W. M. Murphy, of Dublin, also states in the same "issue of the above *Journal*, that according to his experience Great Britain was behind the whole world in the matter of electric traction, which could not be better illustrated than by saying that the city of Glasgow, having acquired the tramways a little more than a year ago, bought a new horse plant to work them instead of an electric plant."

The city of Dublin has now a very successful electric tramway system, and the above shortcoming on the part of Glasgow will shortly be remedied.

But it is to the United States and Canada, where electric traction has been longer in vogue than on this side of the Atlantic, that we must look for the greatest advance and the most economical working; and whereas in Europe installations have been so recently installed that comparative figures of the cost of animal and mechanical traction are difficult to obtain, in the United States and Canada definite figures and a basis for estimates is easily arrived at.

I have received from Mr. John Nuveen, a Chicago correspondent, in whom I have the greatest confidence, the following figures as obtained by him from an expert in electrical traction: "The expense of running a 100-car line with horse power per car per mile is usually estimated at 32 cents."

The following is the expense of running electric lines: "Chicago General Railway Company (Twenty-second-street line), 11 cars. Expense per car per mile, 9·7 cents. Expense of running the Cleveland Electric Railway Company, 275 cars, per car per mile, 8·2 cents." I venture to give the following extracts from the *Scientific American*, May 23, 1896: "Operating expenses and cost of equipment: The old horse-car road in large cities operated at a total cost of from 18 to 25 cents per car-mile. One car mile is taken as the standard for operating expenses in our tramways service. The heaviest item in this operating expense was the question of power—that is, the care and maintenance of the horses, their feeding, and the depreciation of same. The average life of a horse on a well-operated tramway road is five to six years, and the number of horses required per car from eight to eleven, according to conditions and requirements. The cost of this power service *was from* 8 *to* 11 *cents per car mile.* This is where the electric road has made its heaviest gains in the reduction of operating expenses. *This item is reduced in* (*electric*) *power service* to-day to a cost, under general conditions, *ranging from* 1 *to* 1½ *cents* per car mile. Is this not a marvellous gain in a few years, and does it not indicate and show the possibilities of the introduction of this power on this service? The relative proportion of operating expenses to earnings in the horse railway service was from 70 *to* 80 *per cent. operating expenses to gross earnings.* In electric service we have a considerable increase in our gross earnings over our old horse line, *which increase runs from* 25 *to* 50 *and even* 100 *per cent.*, in some cases, and the operating expenses being 40 *to* 60 *per cent.* of the gross earnings."

I also give an extract from the report (dated January 14, 1896) of the Metropolitan Traction Company operating the New York tramways: "Mileage operated by cable and conduit underground electric systems, 32·12; still operated by horses, 131·38; total mileage of the company, 163·50. Of the net earnings, more than 73 per cent. came from the mileage now operated by mechanical traction. That is, with four-fifths of the mileage of the system still operated by horses, and therefore undeveloped, the net earnings of the one-fifth thus far improved have been so large as to carry the entire investment. It is not only through an increase of business that this is brought about, but also through economy in operation. When the entire traction system was operated with horses, the cost of the operation was 70 per cent. of the gross receipts. The substitution of mechanical traction upon 20 miles of 122 reduced the cost of operation of the entire system to 54·39 per cent. by the substitution of mechanical traction for horses. These figures indicate very plainly what may be expected of this system when it shall be supplied with mechanical traction throughout, and be in other respects fully developed."

The New York City Corporation has refused the company the privilege of having an overhead system, but New York has been amongst the first to successfully instal the underground or conduit system. Many improvements have been made in this system since the experimental line was started in Budapest a few years ago; and from enquiries made from reliable sources, both in New York City and Canada, I am assured that there is not the least doubt as to the successful and economical working of this system, not only in New York but in other important American cities, and it is stated to be even more economical in working than the overhead trolley system, although more expensive in the cost of installation.

I have no doubt that further improvements will shortly be made in this system of electric traction.

I have also had particulars and description of another system which has just been placed on the market—the "Johnson-Lundell"—which requires no underground conduit at all. It is now working on a short experimental line in New York City. The Westinghouse Electric Company, 32, Victoria-street, S.W., have also introduced a *closed*-conduit system on somewhat the same principle.

The figures given as to the working of the electric system in Toronto, Canada, are very instructive. The company pay to the city a fixed sum per mile and a movable percentage of the gross takings according to the total annual receipts.

Since the establishment of the electric system, the cost of working has been reduced by 30 per cent., and the gross takings or increase of business has increased a like amount of 30 per cent.

The Corporation received last year as its payment from the company the sum of 138,196dol., a sum equal to, say, £28,500.

Toronto has a population of 175,000, and if a like pro-

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portionate success were obtained in the county of London, which has a population more than 25 times greater, the annual income would be over £712,000 per annum.

The same report (just issued) states that it is estimated that the citizens save by the system of transfer, without extra fare, as much as 100,000dol.—say £20,618—per annum, and although this sum does not go into the city treasury, the citizens get the benefit of it.

The Montreal Street Railway Company shows an equally satisfactory increase in traffic and profits since the conversion to the electric system, as the following extract from the company's published report for 1895 will show: "The cost of operating during the entire year averaged 59·20 per cent. of the receipts, as compared with 82·68 per cent. for 1892 (under horse traction). It is satisfactory in referring to the statistical statement to draw attention to the good result obtained by the conversion of the system to electricity. While the receipts for 1895, as compared with 1892, have grown from 564,406dol. (say, £116,372) to 1,102,777dol. (say, £227,377), the operating expenses have only increased 186,166dol. (£38,384), and the net earnings have increased from 97,761dol. (say, £20,156) to 449,965dol. (say, £92,776). The number of passengers carried has grown from 11,631,386 to 25,877,758. No other company your directors can truthfully say has experienced more gratifying results than these in the conversion of its system to electricity."

I think it will be seen from the foregoing that the earning power of a tramway under usual conditions may soon be doubled by the adoption of the improved systems of tramway traction now in the market, as well as immensely augmenting the satisfaction given to the public, and I believe that the possibilities of London in this direction are equal to those of any city in the world.

The clauses in the proposed agreement with the North Metropolitan Tramways Company—and the fact that the company has a comparatively short lease, and will naturally be desirous of continuing to use their present plant and continue their present system—are not in my opinion at all likely to ensure the improvements that London needs, nor the profit to the ratepayers that this valuable property should yield. I therefore trust that a true estimate of our tramways may be arrived at before we commit ourselves to the entirely inadequate figures that are proposed.

In submitting the foregoing considerations, I would urge that the fullest possible enquiry and examination of the various systems in use on both sides of the Atlantic be made and their value for London ascertained.

I am of opinion that by thus holding our hands until these investigations are made, the value of our property, whether worked by a company or by the Council itself, will not depreciate, but quite the reverse; and it must be acknowledged by all that for the greatest city in the world, whose streets present an ever-increasing difficulty through the congestion of traffic, too much thought and care cannot possibly be given to secure for it the best and most advantageous system that can be obtained.

ELECTRIC AND MAGNETIC RESEARCH AT LOW TEMPERATURES.*

BY J. A. FLEMING, M.A., D.SC., F.R.S., M.R.I.

(Concluded from page 694.)

The chart (Fig. 8) before you shows how the electrical resistance varies between the limits of −200deg. C. and 100deg. C. when the alloy is taken through a cycle of temperature beginning at 100deg. C. in its non-magnetic state. The 29 per cent. nickel steel exhibits the same characteristics in a less marked degree. A close study of this interesting material shows that there is room for much valuable work upon it yet. A manganese steel brought to notice by Mr. R. A. Hadfield, having about 12 per cent. of manganese in it, is also capable of existing in two states—a magnetic and a practically non-magnetic variety. The magnetic variety, which is much more brittle, is, however, in this case, formed by the prolonged slow heating of the non-magnetic variety out of contact with air. In the non-magnetic condition the material has a very high specific resistance at 0deg. C.—about 65,700 C.G.S. units per cubic centimetre; but the magnetic variety has a much lower specific resistance—viz., about 51,400 C.G.S. units at 0deg. C. In all these cases it is interesting to note that the change of the alloy into the magnetic variety is accompanied by a decrease in resistivity or increase in conductivity; in an increase in brittleness. We have tried cooling this non-magnetic variety of manganese steel in liquid air, but have not been able in that way to make any change in its condition as regards magnetic susceptibility. There is a particular alloy of copper 84 per cent., manganese 12 per cent., and nickel 4 per cent., called manganin, which at ordinary temperature exhibits but little change of resistance with change of temperature. On taking the curve of its resistance over wide ranges of temperature, we find that its curve is very concave downwards, and the vertex of the curve lies at about 16deg. C. Hence at ordinary temperatures small changes of temperature make no change in its resistance, but above this point its temperature coefficient is negative, and below it it is positive. All alloys in which a negative temperature coefficient has been observed are probably instances of the same mode of variation of resistance. It may be noted, in passing, that the element manganese when present in an alloy seems to have a great tendency to produce high resistivity and small temperature coefficiency. Returning, then, to the pure metals, we may ask, What is the meaning of the fact that in their case the resistance lines all converge so as to indicate that the electrical resistance would vanish at the absolute zero of temperature? We know that the passage, as we call it, of an electric current through a conductor heats it, and that by Joule's law the rate of production of heat in the conductor

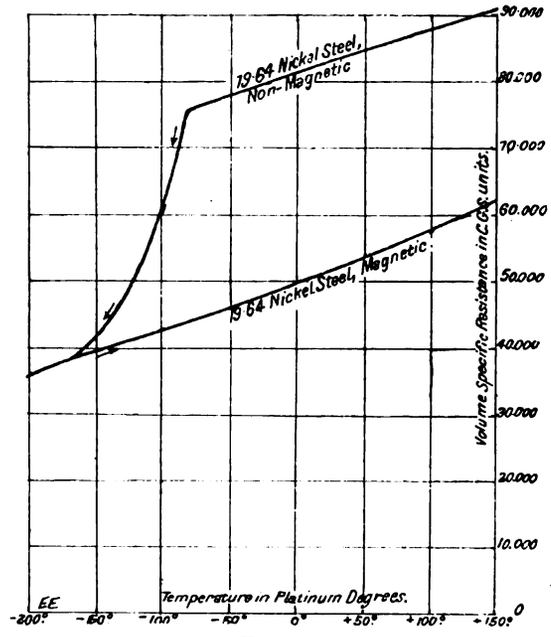

FIG. 8.

is proportional to the square of the current strength and to the total resistance of the conductor. Suppose we take two wires, say, of iron and a certain copper-nickel aluminium alloy, of the same size and length. These wires will, at +100deg. C., have the same resistance. A unit current flowing through them will therefore generate heat in them both at the same rate. Cool them both down, however, to the temperature of liquid air. In the case of iron the resistance is reduced to one-fifteenth of its value at -200deg. C.; in the other case it is only reduced by only 10 per cent. Hence, at the low temperature the alloy dissipates energy for the same current nearly 13½ times as rapidly as the nickel.

It is a logical deduction from all we know to conclude that if we could reach the absolute zero of temperature, the pure metal would not dissipate the energy of the current at all. Imagine two iron wires, then, stretched through space, say, from the earth to the moon, and kept everywhere at the absolute zero of temperature. We could transmit any amount of electrical energy along them without dissipating any of it as heat in the wires. As a consequence of this, any pure metal cooled to the absolute zero of temperature would become a perfect screen for electromagnetic radiation, and would be perfectly impenetrable to electromagnetic induction. We can show this increase in the power of electromagnetic screening by metals when cooled in the following way: A suitable coil of wire is placed between the poles of an alternating-current magnet and a small incandescent lamp connected with the coil. When the magnet is excited it induces currents in the coil, and the lamp glows up. A cap of aluminium is made of such a size as to drop easily over the coil. This aluminium is not of sufficient thickness or conductivity to screen off the induction when it is warm. If, however, we cool the aluminium cap in liquid air and then

* A Friday evening discourse delivered at the Royal Institution, June 5, 1896. Lord Kelvin in the chair.

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drop it over the coil, the lamp for one instant goes out, but it comes in again as the metal cap instantly warms up. This shows us, however, that if the cap were at the absolute zero of temperature it would be a complete screen for the induction. In fact, these experiments furnish us with a new definition of what we mean by the absolute zero of temperature. It is the temperature at which perfectly pure metals cease to have any electrical resistance.

In the conduction of currents at ordinary temperatures, as we generally know it, two effects are inseparably connected with the conveyance of energy by this process. One is the dissipation of some of the energy as heat in the conductor, the other is loss of potential or fall of electric pressure, and which is one of the factors in the equivalent of the energy so dissipated. If, however, the conductor is at the absolute zero of temperature, there is no dissipation of energy in it, and neither of these consequences would be present. There would be no heat produced in the conductor and no fall of potential along it either for large or small currents. What, then, under these conditions is the function of the conductor? The answer is that it becomes a mere boundary, serving to limit the electromagnetic field and determine the direction in which the energy transmission is taking place. These experiments, therefore, may be regarded as forging one more important link in that chain of evidence which compels us to look for the processes concerned in the conveyance of energy by an electric current, not inside the conductor,

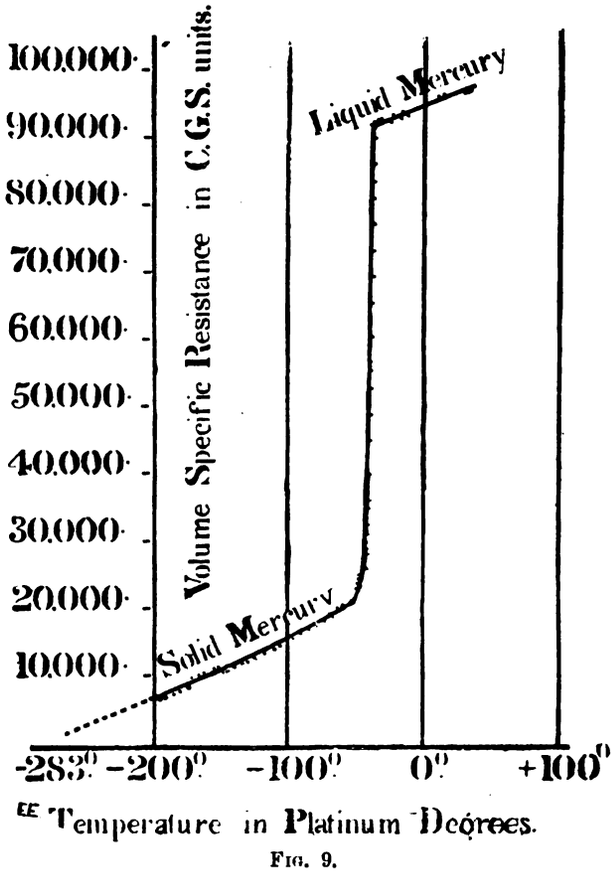

FIG. 9.

as we call it, but in the dielectric, or medium outside. We may, then, ask how is it that different bodies have such various dissipative powers when acting in this way as the boundary of an electromagnetic field? The only suggestion on this point I venture to make here is as follows: Materials of high specific resistance have all probably a very complex molecular structure. The alloys of high resistivity are not probably merely solidified mechanical mixtures of metals, but chemical compounds; and even in the case of elementary bodies like carbon and sulphur they may have, owing to their high valency, and tendency of their atoms to auto-combination, a complex molecular structure. This structure may bestow upon them the power of taking up energy from the electromagnetic medium, just as gases with a highly complex molecular structure are very absorbent of radiant heat, which, if the electromagnetic theory of light is true, is only another form of electromagnetic energy. All we know at present about the processes at work during the time a conductor is traversed by an electric current is that there is a magnetic field outside the conductor and also within the mass of the conductor, and that some mechanism is at work absorbing energy through the surface of the conductor and dissipating this as heat in the interior. The resistance of a conductor is best defined as the number expressing the rate at which it dissipates electromagnetic energy per unit of current. For the same current—that is, for the same external magnetic field—conductors dissipate this energy at very different rates. Some, like silver and copper, which have the lowest rates, are elements of low valency and molecular volume, and have probably a simple molecular structure. Others, like alloys of high resistivity, have in all probability a more complex molecular structure. Both this last, as well as the molecular mobility characteristic of the liquid state, are conditions which bestow the power of taking up rapidly and dissipating the energy of the electromagnetic field, and this has to be kept supplied from energy-transforming sources. We cannot, however, at present construct profitably further mechanical hypotheses to account for this difference in the presence of our great ignorance about ether, molecules, and energy.

In passing from the liquid to the solid state there is generally an immense increase in the conducting power of metals. This is well shown in the case of mercury. A glass tube a metre in length was formed into a spiral coil and fitted with pure mercury, suitable connections being provided at the ends. This coil was embedded in a mass of paraffin wax, and a platinum-wire thermometer placed in contact with it. The whole mass was then reduced to the temperature of liquid air, and observations taken of the resistance of the mercury as it heated slowly up after being removed from the liquid air. The curve in Fig. 9 shows the manner in which the resistance increases with great suddenness between 41deg. and 36deg. as the metal passes into the liquid condition. The resistance becomes four times greater between −50deg. and −36deg. in the course of 14deg. rise of temperature, and whilst in the act of passing through the melting point of the mercury at −38·8deg. C. This chart shows that the resistance of the mercury in the solid state tends downwards, so as to indicate that its resistivity would completely vanish exactly at the absolute zero of temperature. It is interesting to note also that the portion of the resistance curve belonging to mercury in the solid state is sensibly parallel to that portion of it in the liquid state.

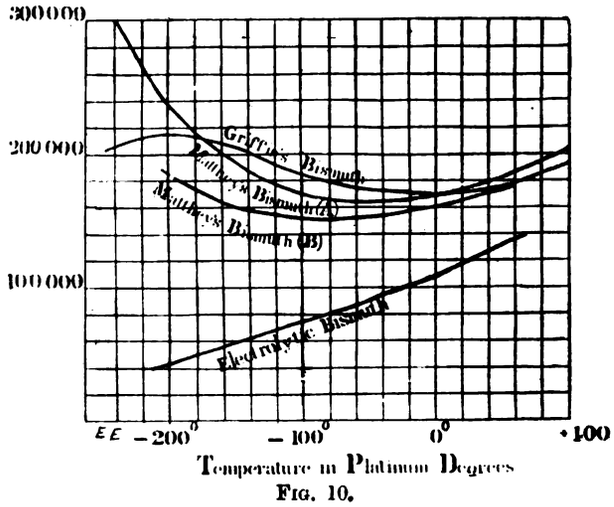

FIG. 10.

We carried on a long struggle with bismuth in the endeavour to unravel some of the electrical peculiarities of that metal at low temperatures. Chemists are aware of the extreme difficulty of preparing bismuth in a state of perfect chemical purity by purely chemical means. From several different sources we procured bismuth which had been carefully prepared by the reduction of the oxychloride, or nitrate, after careful reprecipitations. This bismuth was then pressed into wire, and its resistance curves taken down to the lowest attainable temperatures. We found some very extraordinary results. Although sensibly agreeing in resistivity at ordinary temperatures, in two cases the resistance curves had a minimum point, and after reaching this at about − 80deg. tended upwards again, showing that the resistance was increasing as the metal was further cooled. These curves could be repeated as often as necessary with these samples. Another specimen gave a curve with a double bend (see Fig. 10). These results convinced us that it would be necessary to prepare bismuth electrolytically, and with the assistance of Messrs. Hartmann and Braun, of Frankfort, who have made a special study of the preparation of electrolytic bismuth, we were provided with a quantity of the metal, which examination showed to be chemically pure. On taking the resistance curve of a sample of the electrolytic bismuth when pressed into uniform wire under great pressure, we found that its behaviour was perfectly normal, and that the resistance line tended downwards, as in the case of all other pure metals, to the absolute zero. Also we found that the specific resistance of this last very much less than that of the chemically-prepared samples, and less even than that employed by Matthiessen. Hence, *pure* bismuth is no exception to the law enunciated above. Bismuth is characterised especially by many peculiarities. It has been known for some time that the resistance of a bismuth wire is increased

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when it is placed in a magnetic field so that the lines of the field are perpendicular to the direction of the current flow. This is easily shown by means of one of Hartmann and Braun's spirals, manufactured now purposely for measuring magnetic fields.

We have, however, discovered that if bismuth is cooled to the temperature of liquid air, the effect of any given magnetic field in changing its resistance is increased many times. Thus, for example, a certain bismuth wire we used had a resistance of 1·690 ohms at 20deg. C. Placed in a magnetic field of strength 2,750 C.G.S. units, its resistance was increased to 1·792 ohms, or by 6 per cent. The wire was then cooled in liquid air, and its resistance lowered to 0·572 ohm. On putting it then into the magnetic field of strength 2,750 C.G.S. units, its resistance became 2·68 ohms. Hence, it had increased 368 per cent. This magnetic field can then actually reverse the effect of the cooling and cause the bismuth, when cooled and magnetised, to have a greater resistance than when at ordinary temperatures and unmagnetised. We are at present engaged in further unravelling the problems presented by this new discovery with regard to bismuth. It is certainly very startling to find that a magnetic field which increases the resistance only 5 per cent. at ordinary temperatures increases it five times at - 186deg. C. It will be seen that this process of taking the resistance of a conductor in liquid air is one which affords us a very critical means of discrimination as to the chemical purity of a metal. It ranks almost with the spectroscope as an analytical method.

Time will only permit one brief reference to the behaviour of carbon in regard to electrical conductivity when cooled to low temperatures. We have found that carbon in the form of carbon filaments taken from various incandescent lamps continued to increase in resistance as it was lowered in temperature. The resistivity at various temperatures of the carbon from an Edison-Swan lamp at various temperatures is as follows:

C.G.S. units.	Temperature.
$3{,}835 \times 10^3$ at	99° C.
$3{,}911 \times 10^3$,,	18°·9 C.
$3{,}953 \times 10^3$,,	1° C.
$4{,}054 \times 10^3$,,	- 78° C.
$4{,}079 \times 10^3$,,	- 100° C.
$4{,}180 \times 10^3$,,	- 182° C.

These values when represented on a chart give almost a straight line, and show that the resistivity of carbon continually increases as it is cooled, but at a very slow rate. The temperature coefficient is therefore negative, and of about the same absolute magnitude as many alloys of high sensitivity. The resistivity of this form of carbon is about three thousand times that of silver. Adamantine carbon taken from a Woodhouse and Rawson lamp had a resistivity 50 per cent. greater.

All the so-called insulators—*e.g.*, glass, guttapercha, ebonite, paraffin—have resistivities enormously greater than that of carbon, but, like it, their resistance increases as the temperature is lowered. For the sake of comparison we have placed upon this chart of lines of metallic resistivity the resistance line of carbon, with ordinates drawn to a scale of one-hundredth part of those of the metals. To properly represent to the full scale the line of carbon, this chart, which is 15ft. long, would have to be made one-third of a mile long. If we desired to represent on the same scale the resistivity of guttapercha, the length of the chart would have to be billions of miles; in fact, so long that light would take 5,000 years to traverse it from one end to the other. Even then, to represent to the same scale the resistance lines of paraffin and ebonite, it would have to be 30 or 40 times longer.*

We must next pass on to consider some problems in thermo-electricity which have engaged our attention. If we construct a thermo-electric couple of two metals in the form shown in the diagram (see Fig. 11), and connect this with a galvanometer, and if one junction is kept at a constant temperature—say 0deg. C.—whilst the other junction is heated or cooled to various temperatures, we shall in general, but not always, find an E.M.F. acting on this circuit when the junctions are at different temperatures. This E.M.F. depends on three things—the nature of the metals, the temperatures of the junctions, and on a certain temperature called the neutral temperature of the metals. An important matter in the experimental theory study of thermo-electric action is to discover the position of these neutral temperatures when different metals are tested with lead as the standard of comparison, and when one junction is kept at 0deg. C. Elaborate experiments made by Prof. Tait many years ago furnished full information on this matter for temperatures lying above 0deg. C., and we especially desired to extend this knowledge to ranges of temperature between 0deg. C. and -200deg. C. Accordingly a number of thermo-electric junctions were prepared of various pure metals and alloys, the comparison metal being always pure lead. These couples were grouped together, and one set of junctions always kept at 0deg. C. in melting ice. The other sets were cooled to various low temperatures by means of liquid air. The experimental process then consisted in measuring the E.M.F. set up in each length respectively, and at the same instant measuring the temperature of the low-temperature junction. After various failures a device was adopted for making this double measurement with great accuracy and expedition. The arrangement consisted of a combined potentiometer and resistance balance. A long uniform wire, stretched over a scale, had a battery connected to its two ends so as to make a fall of potential down the wire, which could be regulated by appropriate resistances. It will be easily seen that we can combine a galvanometer and resistance coil with this arrangement in such a manner as to form it into a Wheatstone's bridge or a potentiometer. In this latter form of instrument an unknown E.M.F. is balanced against the known fall of potential down a certain length of a graduated wire, and a galvanometer employed to ascertain the point on the slide wire at which this is the case. Omitting details, it may be stated that we succeeded in devising an arrangement of circuits in which this change from a potentiometer to a resistance bridge was effected by moving two brass plugs from one pair of holes to another. This instrument formed a combined resistance and E.M.F. measurer which enabled us to do two things: first, to measure the E.M.F. in any thermo couple; secondly, to measure the temperature of the low-temperature junction by measuring the resistance of a platinum wire wound round that junction and acting as a thermometer. In actual practice the platinum thermometer consisted of a small hollow copper cylinder. In the interior of this cylinder were inserted a number of the thermo junctions, and round the outside was wound the platinum thermometer wire. Aided by this device we were able to measure temperatures with an accuracy of 1-25th of a degree at a temperature of -200deg. C., and to ascertain at the same instant the exact E.M.F. acting in the couple. When these arrangements had been perfected, the method adopted was to put one set of the junctions in melting ice. The other set, enclosed in the copper cylinder, were embedded in a mass of paraffin wax, which was then cooled down to the temperature of liquid air. The mass was then removed and inserted in a vacuum vessel and allowed to heat up very slowly. At frequent intervals during the heating the E.M.F. of the couple was taken, and also the temperature of the junction.* The events which under some conditions

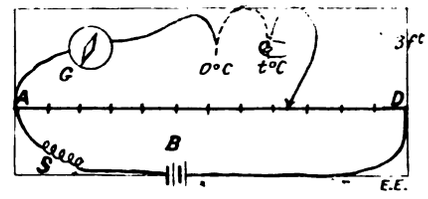

FIG. 11.

happen in the case of a platinum-lead junction can easily be shown, and are very interesting. At the first immersion of one junction in liquid air whilst the other is in melting ice, we get a current, as shown by the galvanometer, in one direction. On lifting one junction out of the liquid air it begins to warm up. The first effect of this heating is to reduce the thermo current in the circuit. At about - 111deg. on our platinum scale—some distance, therefore, above that of liquid air—the current in the circuit falls to zero. As the junction continues to heat up, the current increases again in the opposite direction. At about -60deg. the low-temperature junction reaches the temperature called the neutral temperature, and the current is a maximum in one direction. It then begins to fall off once more, and it finally becomes zero again when the two junctions are both at the temperature of melting ice, and it, lastly, increases in the opposite direction as this variable junction continues to warm up from 0deg. C. to higher temperatures.

Having carried out the observations described with all our thermo couples, the results were represented in a chart† as follows: A horizontal line was taken on which were marked off divisions representing platinum temperatures; vertical ordinates were then drawn at various temperatures for each couple representing the E.M.F. on the couple when the cold junction was at the temperature denoted by the abscissa of that ordinate. In this way a series of curves were delineated which all passed through the point representing 0deg. C. These curves are the curves of thermo-electromotive force. In Prof. Tait's researches on this subject he adopted a method of representing the facts which has many advantages. Suppose the couple to have one junction at a constant temperature and the other to be varying. At any instant the E.M.F. of the couple is varying at a certain rate with the changing temperature of the non-

* The resistivities of platinoid, carbon, and guttapercha at 0deg. C. are nearly in the ratio of the numbers 4×10^4, 4×10^6, and 4×10^{23}.

* For fuller information see Dewar and Fleming on the "Thermo-Electric Powers of Metals and Alloys." *Philosophical Magazine*, July, 1895.

† This was given in error in our last number as Fig. 7.

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constant junction. This rate measures what is called the thermo-electric power of the metals with respect to each other at that temperature. If we measure the slope of the E.M.F. curve at any point, it can easily be shown that the numerical value of this slope gives us the rate of change of E.M.F. with temperature. If we plot these slopes in terms of the corresponding temperature, we obtain another set of curves called curves of thermo-electric power. Lead is always taken as the standard metal for comparison because the Thomson effect in lead is zero. From our chart of thermo-electromotive forces we have constructed another one of thermo-electric powers. The lines of thermo-electric powers cut the lead-line in various places, and the temperature at which they do this is called the neutral temperature of that metal with respect to lead. Prof. Tait deduced from his experiments that these thermo-electric lines were straight lines for temperatures above zero Centigrade, and he made, in addition, the important discovery that for certain metals, such as iron and nickel, the thermo-electric lines have sudden changes of direction at high temperatures.

The general result of our investigations at low temperatures is to show that whilst in some cases the thermo-electric lines are approximately straight lnes for temperatures down to the lowest reached, they are not all by any means straight lines. In some cases, such as iron and bismuth, we find sudden changes of direction of the thermo-electric lines similar to those found by Prof. Tait at higher temperatures, and this indicates a change in sign in the Thomson effect at that point. Moreover, in many cases there is a decided tendency of the lines of many metals to bend round in a manner which indicates that their thermo-electric power probably would become zero at the absolute zero of temperature.

The temperature at which the thermo-electric line of any metal crosses the line of lead gives us the neutral temperature of that metal with respect to lead, and at that temperature the metal is thermo-electrically identical with lead. If one junction of a couple is at a temperature as far above the neutral temperature of the metals as the other is below it the couple will give no E.M.F. This provides us with an experimental method of determining the position of certain neutral points. Thus, for instance, if one junction of a platinum-zinc couple is placed in liquid air and the other is raised to about 30deg., we get no E.M.F. from that couple. This indicates that the neutral temperature of platinum and zinc is about −85deg., and this is shown to be the case from the chart. Two general conclusions are arrived at from a study of the thermo-electric lines as laid down in our chart. The first of these is that the thermo-electric lines of many metals are by no means straight lines over extreme ranges of temperature. Hence the thermo-electric power is not simply a linear function of the absolute temperature. The second important fact is that in the thermo-electric lines of certain metals at low temperatures there are sudden changes of direction, which indicate a change in the sign of the Thomson effect in that metal, and probably, therefore, some important molecular change at the corresponding temperature.

Leaving the further elaboration of these points, we must next notice some of the facts with respect to the magnetisation of iron at low temperatures. Prof. Dewar mentioned in a discourse on the scientific uses of liquid air some results obtained on cooling small steel magnets. These effects we have since again explored by us at greater length. Let me show you in the first place the effect of cooling a small steel permanent magnet to the temperature of liquid air. We will first take a magnet made of knitting-needle or ordinary carbon steel, and examine the effect of low temperature upon it. Placing the magnets behind the small suspended magnetic needle of a magnetometer, we obtain a deflection of the magnetometer needle which is a measure of the magnetisation of the magnet causing the deflection. On bringing up a small vessel of liquid air and immersing in it the magnet under test, we notice at once a sudden decrease in the deflection of the magnetometer needle. This indicates that a notable percentage of the magnetisation of the magnet has been removed. On taking away the air bath and allowing the magnet to heat up again, we find that there is a still further decrease in magnetisation. On cooling it again with liquid air the magnetisation increases, and from and after that time the effect of the cooling is always to increase the moment of the magnet, and the effect of heating it up again always to decrease the moment of the magnet. Hence we see that the effect of the first immersion in liquid air was to give a shock to the magnet which deprives it permanently of a considerable percentage of its magnetism, but when once it has survived this treatment, then cooling it strengthens the magnet and warming it weakens it. This is not by any means always the case. If we take a magnet made of the 19 per cent. nickel steel, the peculiar characters of which were explained a few moments ago, we shall find a very different state of affairs. Here we see the first effect is, as before, to remove a very considerable percentage of the initial magnetisation, but after that stage is passed, then cooling this nickel-steel magnet always weakens it still more and warming it up again strengthens it. The subsequent effect of cooling is therefore in the opposite direction in the carbon steel and in this nickel steel.

We have in this way examined the behaviour of magnets made of a very large number of steels—chromium steels, aluminium steels, tungsten steels, silica steels, and nickel steels in various states of temper hard and soft. We find that in some cases there is no initial decrease of magnetism at all, and that the steady state begins at once. Broadly, however, the results amount to this: a steel magnet when plunged into liquid air generally loses some fraction of its magnetisation, but that after a few such immersions it arrives at a fixed condition, in which the effect of cooling it is in most cases to produce an increase of magnetic moment, but in a few exceptional cases to produce a decrease of magnetic moment.

In the technical use of magnets for instrumental purposes they have to go through a process called *ageing* to get rid of the sub-permanent magnetism. One of the best ways of ageing a magnet is to plunge it several times into liquid air. We have given a large amount of attention to a study of the changes taking place in the magnetic qualities of soft or annealed and also hard iron when cooled to very low temperatures. In the first place, we have examined the change in the permeability of iron at the temperature of liquid air. If a ring of iron is wound over with a coil of wire and subjected to gradually increasing magnetising forces, this produces magnetisation in the iron, but the magnetisation does not increase proportionately with the force.

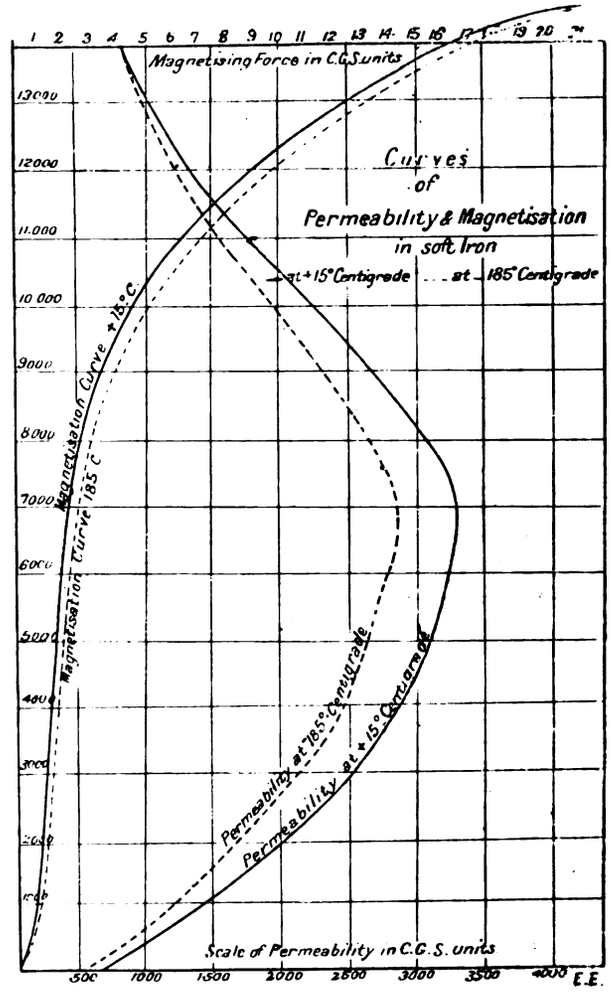
Magnetising Force in C.G.S units
Curves of Permeability & Magnetisation in soft Iron
at +15° Centigrade
at -185° Centigrade
Magnetisation Curve +15°C
Magnetisation Curve -185°C
Permeability at -185° Centigrade
Permeability at +15° Centigrade
Scale of Permeability in C.G.S. units
E.E.

FIG. 12.

It tends to a limit, and the curve which shows this variation is called a magnetisation curve. The number which expresses the ratio of the magnetisation to the magnetising force is called the susceptibility of the iron. Instead of considering the magnetisation of the iron as one of the variables, it is often convenient to consider the induction in the iron, and the induction is defined as a quantity the rate of change of which with time measures the E.M.F. set up in a secondary circuit wound round the iron ring.

The ratio between the induction and the magnetising force at any instant is called the permeability of the iron. By tedious experiments with the ballistic galvanometer, it is possible to draw out a complete magnetisation curve of the iron, starting from the lowest induction up to the point at which the iron becomes practically saturated. Assisted by Mr. J. E. Petavel, who has given us most valuable help in these very tedious magnetic observations, as well as the subsequent reductions of them, we have made a large number of observations on the permeability of a carefully annealed iron ring made of very fine

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Swedish iron of the highest quality* (Fig. 12). The result is to show, as seen from the curve (Fig. 13), that cooling the iron to −200deg. slightly diminishes the permeability. In other words, it requires a greater magnetic force to produce a given amount of magnetisation when the iron is at −200deg. than when it is at the ordinary temperature. When, however, we began to study the behaviour of hardened iron in this respect, we found ourselves in the presence of very curious effects. If pure iron which has been carefully annealed is twisted, knocked, bent, stretched, or compressed, it passes into a state known as hard iron; and hard iron has very different magnetic qualities from soft iron. A very extended series of experiments with rings of hard iron have shown that hard iron, at least in certain cases, has its permeability greatly increased by cooling; and this change takes place with great suddenness. We can show you by a simple experiment that this is the case. If we take this hard iron ring, which has two coils of wire wound round it, and connect one of these circuits to a battery, we shall send a current

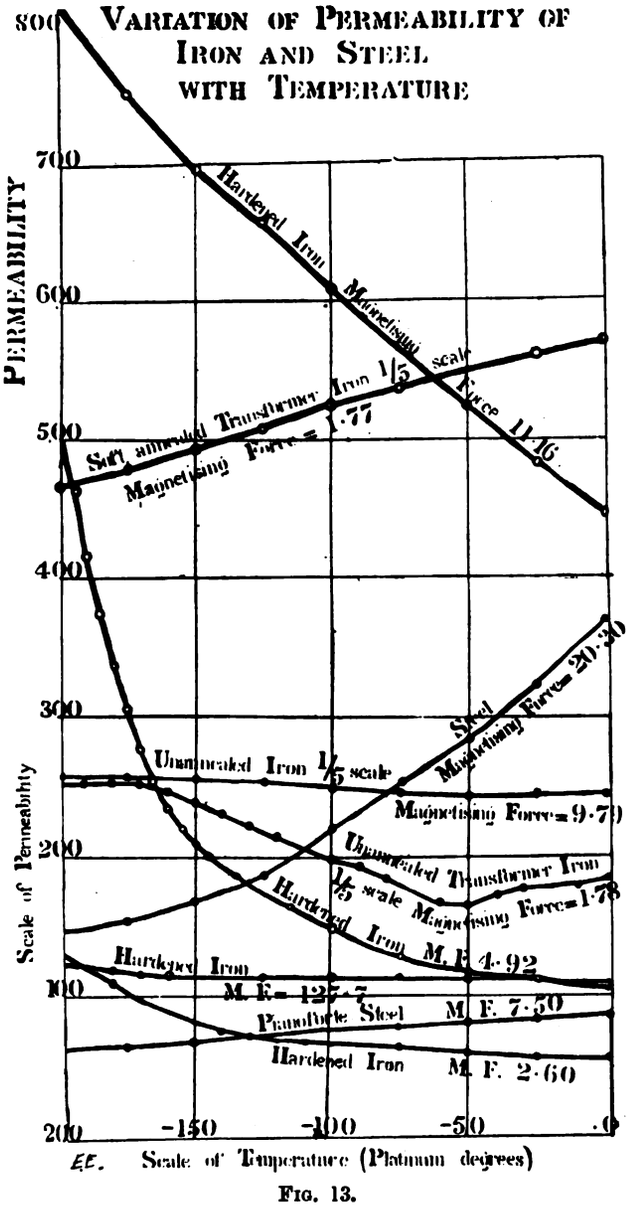

FIG. 13.

through this primary coil and magnetise the iron ring. If the other or secondary circuit is connected to a galvanometer, then at the instant of starting the primary current there is a transitory induced current produced in this secondary circuit. As long as the induction in the iron remains constant, no electric change will take place in this secondary circuit. If, however, we plunge the iron ring into liquid air, we find again a secondary current produced at the moment of cooling the iron. This indicates a sudden increase of permeability at the instant of cooling. If we bring the ring out of the liquid air we find it retains some of the increased permeability acquired on cooling, but loses a portion of it more slowly if it is heated up again to ordinary temperatures by plunging it into a bottle of alcohol. Owing to these changes we found it impossible to repeat again exactly any required magnetisation curve in the case of the hard iron. The sudden cooling alters the magnetic qualities of the iron to such an extent that it is not possible to get it twice in exactly the same state.

By subjecting a hard iron ring to frequent reversals of the same magnetising force whilst it is cooled up slowly from the temperature of liquid air up to ordinary temperatures, we have been able to trace the gradual decrease of the permeability at any constant force throughout this range of temperature.

We have found, on the other hand, that unhardened steel pianoforte wire behaves like soft annealed iron.

We have, then, examined the hysteresis of iron at low temperatures (Fig 14). As the meaning of that term was very fully explained by the inventor of it in a discourse given quite recently, no time need be spent in an elaborate explanation of it. It is sufficient to say that when iron is magnetised and demagnetised or carried round a cycle of magnetisation in which its direction of magnetisation is first in one direction and then in the other, this process involves the expenditure of energy, and such dissipation of energy is spoken of as the hysteresis loss in iron. It would occupy too much time to attempt to explain in full detail the manner in which this dissipated energy can be measured. As a matter of fact, the method we adopted was the laborious but exact one of delineating a complete magnetisation curve of the iron, by means of observations taken with the ballistic galvanometer for various maximum values of the magnetising force. In this way we were able, finally, to arrive at a curve which represented by its ordinates the value of the hysteresis loss in the iron in ergs per cubic centimetre per cycle, and the abscissæ the maximum value of the corresponding magnetic induction.

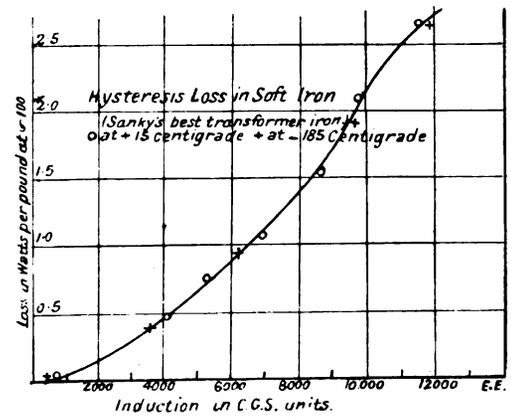

FIG. 14.

When curves had been drawn out from all the many hundreds of observations for the case of the same soft-iron ring at ordinary temperatures and at the temperatures of liquid air, we found little or no sensible difference between them. The result is, then, that there is no appreciable change in the magnetic hysteresis loss of very carefully annealed soft Swedish iron when cooled to these low temperatures. With regard to the hard iron, although the permeability is increased, it is most difficult to say yet whether the hysteresis is increased or not, as every fresh reduction in temperature of the iron alters its physical state, and makes it almost impossible to obtain similar repeated measurements.

It is natural to enquire how far accepted theories of magnetic action are able to reconcile the above-mentioned results. Some of them undoubtedly are in accord with deductions from received hypotheses.

It is generally considered that the facts connected with the magnetisation of iron indicate that each molecule—or, perhaps, small groups of molecules—of the iron are complete micro-magnets, and that in the unmagnetised condition of the iron these molecular magnets arrange themselves in groups or in closed circuits; so that for each little group the external magnetic action or magnetic moment is approximately zero. Magnetisation consists in arranging the members of some or all of those groups so as to collineate the direction of more or less of the molecular magnets and produce an external resultant magnetic moment.

Let us, then, consider one such little group by the aid of a model made of small magnets (Fig. 15), such as Ewing has suggested and used. Suppose the members of this group to be at a certain distance from each other, and we apply a given magnetising force which is just sufficient to open out the group and co-lineate the magnetic axes of the several members of it. Next, suppose we cool this iron; this would result in bringing the members of the group into closer contiguity. The result of this will be an increase of the interpolar magnetic forces of the different members of the group, and as we can see from the behaviour of the model, it would require a greater magnetic force to effect the same amount of collineation of the molecular magnets. This, however, corresponds with what we find to be

* It is only right to add that in other portions of this work we have been much indebted for persevering assistance to Messrs. J. and D. Morris, and in lesser degree to Messrs. Jakeman and Tilney for help in observations requiring several simultaneous observers.

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the case on cooling soft iron to very low temperatures. Prof. Dewar's experiments have shown that the tensile strength of iron and steel is increased to about double on cooling to – 182deg. C., and it is quite reasonable to suppose that this is the result is in part at least due to an approximation of the molecules.

As regards the behaviour of magnets when cooled, it is highly likely that when the groups of molecular magnets have been opened out more or less that some of these are in a condition of instability, in which bringing the members of the group nearer together will have the effect of making them close up again into magnetic circuits of no external action. Hence, if this is the case, the first effect of the sudden cooling will be to effect the change. These half-hearted groups of molecular magnets constitute the sub-permanent magnetism which it is our desire to get rid of in ageing a magnet. Then, as regards the effect of temperature changes on the magnet when the stable condition of affairs is reached. In order to explain this, I think we must consider the action of the molecular groups upon each other. The approximation of molecular groups will in general, after the magnet is aged, have the effect of collineating more completely the different members of the groups, and hence increase the magnetic moment of the magnet, whilst the separation of the molecular groups and the reverse effects ensue on heating.

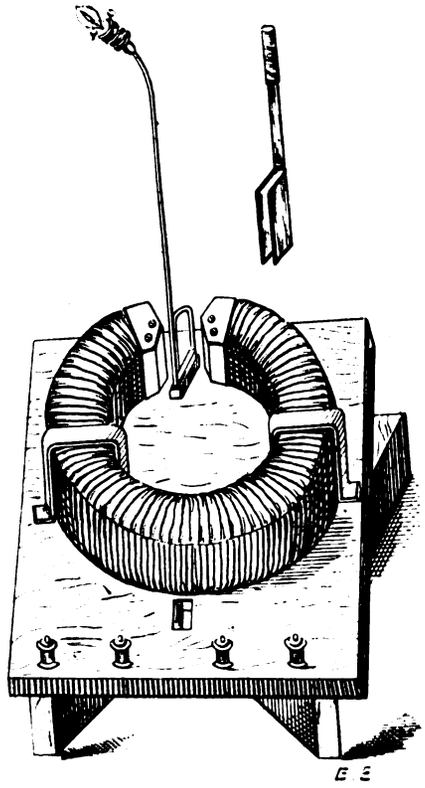

FIG. 15.

The action of the low temperatures upon soft iron and upon magnetised steel would be explicable if we may legitimately make the assumption that lowering the temperature approximates the molecular groups and also the members of each group. The result of this in the case of existing permanent magnetisation is to close up more or less those groups which are in an unstable condition, but it increase the collineation in those groups in which the magnetic moment exceeds a certain value. Hence, in the case of the permanent magnet the first effect of sudden cooling is a compound effect; it consists in a great reduction of the magnetic moment of certain unstable groups, but in an increase of moment of others. After this initial stage is past the normal effect is an increase of magnetic moment of the groups by bringing them closer together and a diminution by increase of distance.

There remains, then, to be explained the anomalous behaviour of nickel steel and hardened iron, but the attempt to throw an inner light upon the results attained with these substances cannot possibly be successful until we have explored far more thoroughly at low temperatures the changes in their mechanical as well as magnetic qualities. However much we may be tempted to speculate upon the causes of these various changes in the properties of matter at very low temperatures, a much more important duty at the present time is the collection of facts and the completion of accurate quantitative measurements. The experimental difficulties of this low-temperature research are very great, but both Prof. Dewar and I have been chiefly anxious in this particular work to prosecute preliminary explorations into as many regions of it as possible, those pioneering experiments enabling us to ascertain in what direction further enquiry will be profitable. Every step forward opens up fresh suggestions for investigation and, I may add, fresh difficulties. In the light of the results, however, thus ascertained we shall have additional means of testing and judging existing electrical theories, and the facts themselves when built into the fabric of scientific knowledge will serve to broaden those foundations on which we may profitably erect new hypotheses of electric and magnetic phenomena, which, even if they cannot dissipate entirely that mystery which enshrouds even the most familiar facts, will serve as a continual stimulus to thought and work in days and years that are yet to come.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ecija (Spain).—The Municipal Authorities of Ecija want tenders by July 2 for a system of electric lighting for the town.

Bucharest.—The Municipality want tenders by July 1 for the electric lighting of a portion of the Boulevard Coltzea. The estimate is about £3,680.

Utrera (Spain).—Tenders are wanted by the Municipal Authority of Utrera for the installation of electric lighting. The last date for receipt of tenders is July 1.

Prestwich.—Tenders for putting into thorough repair the existing telephone system and electric bells at the county asylum, Prestwich, are invited. Full particulars on application at the asylum.

Bucharest.—Tenders will be received up to August 8 by the Roumanian Government (Department of Posts and Telegraphs) for the electric lighting of the new Posts and Telegraph building at Bucharest.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years. Tenders should be sent in by August 31.

Spandau.—Tenders are wanted at the Royal Small-Arms Factory for 900 incandescent electric lamps by July 17. Particulars are obtainable for 75pfg. (9d.) from Die Königl. Direktion der Gewehrfabrik (Geschäftszimmer No. 21), Spandau.

Cazeres-sur-Garonne (France).—Tenders will be received up to June 28 for electric lighting and water supply work and buildings. The estimate is about £2,043. Applications should be made to the Mairie, Cazères-sur-Garonne, Haute-Garonne.

Brussels.—Tenders will be received shortly (the exact date is not yet announced) at the Brussels Bourse for the material and work necessary to start an electric lighting installation at the fifth section of the central locomotive construction works at Malines.

Karlsruhe.—The management of the Baden State Railways at Karlsruhe are prepared to receive tenders up to July 25 for an installation of the electric light at Bretten Station. Particulars are obtainable for 8 marks (8s.) from the Centralbureau der Generaldirektion, Grossh. Badische Staatseisenbahn, Karlsruhe, Germany.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality Tenders must be submitted by September 1 next Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Battersea (London).—The St. Mary's Vestry will receive tenders up to July 14 for a complete installation of the electric light for the town hall and municipal buildings. Specifications and conditions can be obtained from Mr. R. Hammond, Ormond House, Great Trinity-lane, E.C., after a deposit of two guineas has been made with the Vestry Clerk, at the Vestry Offices, Lavender-hill, S.W. Clauses for the payment of trades union wages will be embodied in the contract.

Huddersfield.—Messrs. Learoyd Bros. and Co invite tenders for the wiring of the Trafalgar Mills. Copies of the specifications and general conditions can be obtained from Messrs. Shepherd and Watney, 71, Albion-street, Leeds, on payment of a cheque for £1. 1s, which will be returned on receipt of a bonâ fide tender. Tenders, endorsed "Electric Lighting," must be addressed and delivered to Messrs. Learoyd Bros and Co., Milnsbridge, Huddersfield, by 12 noon on July 7.

San Juan (Puerto Rico).—H.M. Secretary of State for Foreign Affairs has received from H.M. ambassador at Madrid a copy of a Spanish Royal Order which has appeared in the *Gazette* inviting tenders for the construction and working of a telephone system in San Juan de Puerto Rico. A deposit of 800dol. must accompany each tender which will be considered on August 10. The copy of the Royal Order may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6.

Ealing.—The Urban District Council invite tenders for works in connection with the extension of their electric lighting station at

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South Ealing. Drawings and specifications can be inspected, and bills of quantities and form of tender obtained, on application at the office of Mr. Chas. Jones, C.E., surveyor to the Council, between 10 and 4, and upon payment of £2. 2s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Extension of Electric Station," to be delivered at the office of Mr. Wm. Ruston, clerk, Public Buildings, Ealing, W., by 4 p.m. on July 1.

Rochdale.—Tenders are required by the Free Library Committee for the electric lighting plant required at the free public library, consisting of gas engine, dynamo, wiring, and fittings. Plans may be seen and specification and form of tender obtained at the office of Mr. S. S. Platt. A.M.I.C.E., borough surveyor, on payment of a deposit of £1, which will be refunded on the return of the documents and the receipt of a bona fide tender. Tenders, under cover, endorsed "Free Library—Electric Lighting," must be delivered at the office of Mr. James Leach, deputy town clerk, Town Hall, Rochdale, by 12 noon on 30th inst.

Wallasey.—For condensing apparatus and steam and exhaust pipes in connection with their electric light installation, tenders are invited by the Wallasey Urban District Council. Drawings may be seen, and copy of the specification obtained, on application to the engineer, Mr. J. H. Crowther, at the Gas and Water-works, Great Float, near Birkenhead, on payment of £2. 2s., to be returned on receipt of a bona fide tender. Sealed tenders, on the form provided, addressed to the chairman of the Gas and Water Committee, and endorsed "Tender for Condensing Apparatus, etc.," to be delivered at the office of Mr. W. Danger, clerk to the Council, Public Offices, Egremont, Cheshire, by 4 p.m. on July 16 The contractor will be required to enter into a bond, with approved sureties, for the due performance of the contract.

Kingston (Jamaica).—The Colonial Government invite electric tramway contractors willing to undertake the establishment and working of a system of rapid transit to send in applications for the grant of a license by the Governor in Privy Council under the Tramways Law, 1895. In all applications the principal questions to which attention should be directed are the following: (*a*) the amount of capital which the applicants are prepared to subscribe; (*b*) the system which it is proposed to establish; (*c*) the mileage of lines to be laid; (*d*) the fares to be charged; (*e*) the frequency of the service; (*f*) the length of the license required by applicants; (*g*) the guarantee which the applicants offer for the satisfactory performance on their part of any obligations devolving on them. Plans of the city of Kingston and part of the parish of St. Andrew, showing the routes on which the present tramway lines are laid, and copies of the law under which licenses are granted and of the rules made thereunder by the Governor in Privy Council, may be seen at the office of the Crown Agents for the Colonies, Downing-street, London, S.W. All applications must be delivered not later than July 31, 1896, in a sealed packet, marked on the outside "Application for Tramway License," to the clerk of the Privy Council, Kingston, Jamaica. Kingston has its principal means of transit at present supplied by the Jamaica Street Car Company by horse tramcars, the entire length of lines laid being about 12 miles. The concession granted by the Legislature of the island to the Jamaica Street Car Company will shortly expire.

RESULTS OF TENDERS.

Paris.—The contract for the supply of a dynamo at the Buttes-Chaumont generating station has been awarded to the Société Gramme, of Paris, at 4,480fr.

London, S.E.—For engineering work and electric lighting at new public baths and wash-houses, Manor-place, Walworth-road, London, S.E., for the Vestry of St. Mary, Newington, the tender of Messrs. J. F. Clarke and Sons, 49. Moorgate street, E.C., and 41, Featherstone-street, E C., at £6,579, has been accepted.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,900.

Forfar.—The National Telephone Company have begun the work of erecting the alarms for firemen in the burgh.

Aberdeen.—An application from the Harbour Commissioners for the electric lighting of the harbour has been referred to the Electric Lighting Sub-Committee.

Glasgow.—The electric lighting rents of the Corporation were, at the 31st of May, £23 033. 15s. 10d., or an increase of £5,240 on the corresponding period last year.

West India and Panama Telegraph Company.—For the two weeks ended June 15 the receipts were £2,448, as against £2,121 for the corresponding period of 1895.

Windsor.—At a meeting of the Town Council, plans were passed for the conversion of the Albert Brewery into an electric light station for the electric light company.

Worcester.—The report of Mr. Firkins and Mr. Millington on the electric fittings was read at the meeting of the Library Committee, and it was decided to invite tenders for the work.

Rand Central Electric —At a Board meeting, held on Tuesday, the directors of the Rand Central Electric Works decided to make a final call of 5s. per share on all shareholders now registered.

Highgate Hill Tramways, Limited —This Company has been registered, with a capital of £10,000 in £1 shares, to acquire the undertaking of the Highgate and Hampstead Cable Tramways, Limited.

Brush Electrical Engineering Company, Limited. — The transfer-books of the 4½ per cent. second debenture stock of this Company, in view of interest payable on July 1, 1896, are closed until July 2.

Bournemouth.—The Town Council have decided to ask the electric supply company to submit a scheme and estimate for the ordinary lighting of the pier and the illumination of the pier on special occasions

London Extension.—The only notice to come before the County Council last week was one from the House to-House Company to construct a transformer-box in Collingham-place. This was passed by the committee.

The London Tramways Question.—The London County Council discussed at some length at the last meeting the proposals of the tramways syndicate and of the combined companies, and eventually referred the report back.

National Telephone Company.—The transfer-books of the 3½ per cent. debenture stock of this Company are closed until the 30th inst. inclusive for the preparation of the warrants for the half-year's interest due July 1.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending June 21 amounted to £1,221, as compared with £1,245 in the corresponding week of the previous year, being a decrease of £24.

Bangalore.—Five municipal commissioners of the city visited Madras recently with a view to inspect the working of the Madras Electric Tramway prior to making arrangements for a similar tramway service in Bangalore.

Dublin.—The *Belfast News Letter* says it has been announced that the Southern District Tramway Company's electric line from Haddington-road to Dalkey has been purchased by the Dublin United Tramway Company for £273,500

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending June 19 were £2,312. 15s. 9d., compared with £1,860. 12s. 10d. for the corresponding period of last year, being an increase of £452. 2s. 11d.

Barcelona Tramways Company, Limited.—This Company announces the second drawing of its 5 per cent. debentures to take place at the Company's office on July 1; also the closing of the transfer-books of the 5 per cent. cumulative preference shares until July 1 for the preparation of the first half-yearly dividend.

Llandrindod Wells.—Under the title of the Llandrindod Wells Electric Light and Power Company, Limited, a company has been registered, with a capital of £5,000 in £5 shares, to carry on the business of electric lighting in all its branches in the urban district of Llandrindod Wells, Radnorshire.

Wells.—There is some probability of the electric lighting question being brought prominently forward shortly. The Town Council have informed the gas company that the negotiations for the purchase and sale of the gasworks are at an end. This, therefore, leaves the question of lighting open to the advocates of the electric light.

City and South London Railway.—The returns for the week ended June 21 were £836, compared with £794 for the corresponding period of last year, being an increase of £42 The total receipts for the half-year terminating as above were £23,178, compared with £23,093 in the same period of the preceding year, being an increase of £85.

Eastern Extension, Australasia, and China Telegraph Company.—The coupon on this Company's 5 per cent. Australian Government subsidy debentures due July 1 will be paid on and after that date at Messrs. Barclay, Bevan and Co.'s bank, 54, Lombard-street, London, E C. Coupons must be left three clear days for examination.

Dublin.—The Select Committee of the House of Commons which is presided over by Sir Stafford Northcote, is still hearing evidence on the Bill promoted by the Dublin Southern District Tramway Company. A lecture on the past, present, and future of electricity, and its application to Ireland, was delivered recently at Wellington Quay by Captain O'Connor.

Salford.—Some 460 employés of W. T. Glover and Co., electrical cable makers, Springfield-lane, were entertained at a tea and dance on Friday, June 12, to celebrate the completion of the new building at the Springfield-lane works. Mr. Henry Edmunds and Mr. Godfrey B. Samuelson, the principals of the firm, presided at the tables, accompanied by Mrs. Edmunds and Mrs. Samuelson.

Erratum.—In our last issue, page 682, in Mr. Lobley's paper on "The Electric Lighting of Hanley," it is mentioned that Mr. Lobley had "devised a method for lighting incandescent lamps in parallel without sending round the lamplighter." In some inscrutable manner the word "gas" inserted itself between "incandescent" and "lamp," though, of course, the context shows that electric lamps were meant.

Blackwall Tunnel.—The committee of the London County Council have passed the application of the National Telephone Company for permission to lay a 50 twin-wire cable through the subways of the Blackwall Tunnel and erect posts on each side of the river for distributing purposes. The rent to be charged is £5, a free exchange wire from the Council's offices on Northumberland Wharf and free wires between the ends of the tunnel.

Sunderland.—Mr. William Mills, the inventor and maker of patent gear for ships' boats, has commenced an aluminium foundry at the Atlas Works, Bonner's Field, Monkwearmouth, and a number of invited visitors have inspected the novel operation of casting bed-plates for electrical machinery in an aluminium alloy, one set of bed-plates, dynamo-plate, and upper case to support the cylinder though of ample strength, only weighing 1½cwt. in all.

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East Hanningfield.—The rectory has been fitted by Mr. G. W. Clarke with the electric light. The plant is fixed in the adjacent roller mills, which are also lighted by electricity, and consists of a Crompton dynamo, driven by a pair of high-speed compound engines, by Davey, Paxman, and Co., of Colchester. The current, which is at 100 volts pressure, is conveyed to the rectory by means of a pair of copper cables 600 yards in length, and supported on poles.

New Pinos Altos Company.—In their report the directors of this Company state that the Pelton wheel, by the use of which it was hoped to run the mill during last rainy season, was found defective. The manager however, advised that the installation, as now altered is in such a condition that the Company may rely upon obtaining the full advantage from the present season's rains. The Board are considering the feasibility of putting up a plant for running the mill by electricity all the year round.

Shoreditch.—The Vestry have appointed Mr. R. F. Ferguson construction engineer at the Bankside station, to be resident electrical engineer. Mr. Ferguson was previously engineer at a station under the Brighton Corporation. A proposal has been made to utilise the present gas standards in the side streets for incandescent electric lights of 32 c.p. The tenders for insulated conduit cables, switch and fuse boards, and other fittings and materials, have been referred to the Electric Lighting Committee.

Chelmsford.—The annual sports in connection with the Chelmsford Arc Works took place on the Wood-street Ground on Saturday afternoon. There was an unusually large attendance. The boys of the Essex Industrial School and the workhouse inmates had special free invitations. The band of the former institution, together with that belonging to the town, provided the music, whilst the youngsters also went through a very interesting and smartly executed musical drill. The course was in splendid condition.

Bath.—At the meeting of the Urban Sanitary Authority, Alderman Sturges, referring to the question of the proposed introduction of gas to the statutory hospital, stated that he had heard the people on Combe Down were determined to have the electric light. They were going to employ the late surveyor's son, Mr. Parfitt, who had introduced it in Kingswood and Keynsham. The Council should let the matter rest until they know what the residents on Combe Down would do. In one sense he thought the electric light would be better than gas for the hospital.

Rontgen Photography Tube.—In a note in our issue of June 5 mention was made, under its English equivalent, of the name of the Allgemeine Elektricitäts-Gesellschaft of Berlin as being about to bring out a new form of Röntgen photography tube with which results not before obtained could be produced. We have received a communication from the Electrical Company, Limited, of 122, Charing Cross-road, who are the agents for the German firm in this country, to the effect that the improved vacuum tube is now in regular manufacture by the Berlin firm, and, we presume, can be obtained from the Electrical Company, Limited, in the usual course.

Cardiff.—At the meeting of the Property and Markets Committee Councillor Evans made the sensible suggestion that the borough engineer (Mr. Harpur) should be relieved of the electric lighting supervision arrangements, but the suggestion was not taken up. Because Mr. Harpur is one of the ablest of men, that is no reason why he should be saddled with more work than he can possibly get through with any amount of expedition. At a meeting of the Lighting Committee a letter from Mr. J. H Hallett in reference to his charge for reporting on the plant of the electric lighting station was read. Mr. Hallett reduced his charge from £81. 5s. to £60, which the committee agreed to pay.

St. Pancras.—The second annual outing of the Regent's Park central-station staff took place on Saturday, 20th inst. About 30 of the employés journeyed in brilliant weather to Hastings, where they spent a most enjoyable day. At one o'clock an excellent dinner was served at the Manor Hotel, Mr. T. Cooper, M.A., distributing engineer to the Vestry, being in the chair. At the conclusion of the dinner, before the customary toasts, the chairman read letters of regret from Mr. S. W. Baynes, chief electrical engineer, and Mr. E. Cox, chairman of the Electricity Committee, that they were unable to be present. The party afterwards indulged in various excursions on sea and land, and returned to London in the evening.

West Ham.—The Corporation held a special meeting in committee recently when a scheme for the lighting of the borough by electricity was adopted, only five members voting against it. It was also decided to apply for a loan of £67,000 for the purpose of the installation. Mr. G. H. C. Risch is the engineer for the scheme, and, in the course of the discussion, pointed out that arc lighting for public street-lighting was considerably dearer than gas, but they got a greatly improved illumination. The difference in the cost would be £1,045. The gaslight costs £715, the electric light will cost £1,760; but they would get about 50 times the light. The number of the gas lamps displaced will be 177 single-light burners and five three-light burners.

Swansea.—In reference to the electric lighting of the market it was reported to the Town Council that Mr. John Legg and Mr. John S. Brown had been approached with a view to obtaining estimates. Alderman Tutton, in moving the adoption of the report, said there would be a definite report upon the matter in a short time from Mr. Manville. There was a consensus of opinion in favour of the electric light, which would make the market the finest property of its kind in the country. Two excellent schemes had been submitted to Mr. Manville from Mr. J. S. Brown and Mr. John Legge, and Mr. Manville had complimented the men who had drawn up the reports, and nothing further was required. After some discussion the report was adopted.

Metropolitan Electric Supply.—In reference to the terms of the new issue the *Financial Times* says: "The discontent of a considerable number of the shareholders in regard to the methods suggested by the directors of the Metropolitan Electric Supply Company for the issue of the new capital found a vent in the stock markets. The jobbers interested in the shares on Wednesday took a strong line in favour of the views of certain shareholders propounded at the meeting, and quoted prices with a two-point margin instead of the close prices that have prevailed hitherto." The *Financial News*, on the other hand, points out "that by issuing shares at a premium the amount of the necessary issue is lessened, and the shareholders get a direct advantage from the smaller capital on which dividends have to be paid." The position of the founders' shares is not referred to.

Bury St. Edmunds.—At a meeting convened by the Ratepayers' Association to consider the electric lighting scheme of the Town Council, Mr. W. G. King moved, "That this meeting is of opinion that the present is a most inopportune time for the introduction of electric light into the borough, and protests against the proposed expenditure of £20,000 by the Town Council for the same." It was a hobby taken up by certain gentlemen with the best intentions, but the townspeople did not want to be landed in heavy debt. The financial success of the electric lighting scheme was doubtful. Mr. J. Webb seconded. Mr. H. Bankes Ashton considered that before rushing into so large an outlay as was contemplated relative to the electric light, the emphatic opinion of the ratepayers should be ascertained. He knew of eight towns where there had been a surplus, and 17 where there was a deficit during the last year. For size and importance Bury St. Edmunds was not to be compared with the eight towns where electric lighting had been financially successful. The resolution was declared to be unanimously adopted.

Dover.—The question of the tramways was under discussion at the last meeting of the Town Council. The Town Clerk said that with reference to the petition of the London, Chatham, and Dover Railway Company he had applied to know what they required with a view to meeting them and he found that they required the whole of tramway No. 1 beyond the Crosswall crossing to be abandoned. He declined to accede to that, and he also sought the support of the South-Eastern Railway in the matter. On Friday last he received notice that the London, Chatham, and Dover Company had withdrawn their opposition. He had received a communication from the Board of Trade calling attention to the suspension of the standing order by which corporations were prohibited from working their own tramways, and asking if the Corporation of Dover would wish to work their own tramways. He thought it would be best for the Corporation to reserve the powers to work their own tramways. The town clerk was instructed to reply to the effect that the Council would like to retain the power to work the tramways themselves.

Bedford.—At the meeting of the Urban Sanitary Authority, the Electric Light Committee recommended that the Bedford Gaslight Company be informed that on January 1 next the authority will discontinue to use the gas lamps in the following streets—viz: Kimbolton-road, Glebe-road, Pemberley-crescent, Pemberley-road, (southern end), St. Andrew's-road (except northern part), St. Michael's-road, St. Augustine's-road, Park-avenue (eastern end), the whole of St. Mary's and St. John's parishes lying north-east of the Hitchin branch line, and Cauldwell road. Alderman Richards, chairman of the committee, in proposing the adoption of the report, said there were several streets in the town not mentioned in the list where gas lamps had never been erected, but where they proposed to put electric lamps. Mr. Burridge seconded, and it was carried. The committee further reported that they had obtained the balance of the loan (£17,000) at 3 per cent. interest, the principal being repayable in accordance with the terms sanctioned by the Local Government Board, and recommended that the common seal be affixed to a mortgage for £10,000 part thereof. This was carried.

Hull.—At a meeting of the Electric Lighting Committee the members considered a report by a special sub-committee as to the extension of the electric lighting system. The sub-committee recommend the construction of a new generating station at Sculcoates-lane with plant of 760 h.p., and two sub-stations at Monument Bridge and Park-street. The mains to be laid in accordance with this scheme would be along Sculcoates lane, Queen's-road, Prince's-avenue, Springback. Here they would branch off down Derringham street and Park-street, along the Anlaby-road, through the Boulevard, and then up the Hessle road, Walker street, and Porter-street, from thence continuing the circuit through Paragon Station and Brook-street to the Beverley-road. The committee also recommended a main to be laid down Fountain-road and along Waterloo-street and Charles-street. This, it was estimated, would cost £40,679. With the addition of another system down Bankside, over the River Hull at Sculcoates Bridge, through Chapman-street, and so into Holderness-road, Williamson-street, Hedon-road, Great Union-street, and Witham, the cost would be £50,241. The recommendation of the scheme, minus the East Hull extension, was unanimously approved.

Appointments Vacant.—The Metropolitan Asylums Board require at the Brook Fever Hospital, Shooter's Hill, Kent, S.E., a thoroughly experienced working engineer. Wages 42s per week, with board, lodging, washing, and uniform. Candidates must be able to produce certificates as to their qualifications as practical engineers, and be competent to take charge of and do all

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ordinary repairs to the boilers, engines, fittings, electric light apparatus, and the lamps and connections thereto, hot-water apparatus, laundry, and other machinery connected with a large and complete hospital. Forms of application can be obtained at the chief offices of the Metropolitan Asylums Board, Norfolk House, Norfolk-street, W.C., where such forms duly filled up, and accompanied by copies (not originals) of three testimonials of recent date must be delivered by 2 p.m. on July 1 —Applications are invited for the following positions to be held under the scheme for intermediate and technical education in the borough of Swansea: (1) lecturer in metallurgy and chemistry; (2) lecturer in physics; (3) lecturer in engineering. The salary offered in each case is £200, rising, by annual increments of £10, to £250 per annum. Particulars as to the duties, which commence in September next, can be obtained from Dr. G. S. Turpin, the principal, to whom all applications should be sent not later than July 4.

Bury (Lancs.). — The buildings at the central station at Whitehead Bridge are practically finished, and are ready for the machinery, which will shortly be fitted. The buildings include a general office, engine-house, accumulator-house, manager's office, showrooms, fitting-shop, and timekeeper's office. In the boiler-house there is accommodation for two boilers, one of which has already been fixed and the other will be fixed in the course of a week or so. There will be four engines in the engine-room, two of which will be of 240 i h.p. each and the others of 38 h.p. each. Four dynamos will be coupled direct to the engines, and there will be an accumulator to take the light load. The laying of the mains is being pushed forward as rapidly as possible. The compulsory supply area is bounded by Moss-lane, Silver-street, Fleet-street, Rock-street, Clough-street, Rochdale-road, King-street, and Princess-street, but it is intended, before long, to extend the supply to Manchester-road, Bolton-street, and Walmersley-road. It is anticipated that the Corporation will be in a position to supply electricity by next winter. The buildings have been constructed by Messrs Storrs and Sons, Stalybridge; Messrs. Siemens Bros, of London, have the contract for the complete installation and lighting; Mr. W. Lord, of Lord-street, has supplied the boilers; and the whole of the work is being carried out under the supervision of Mr. J. Cartwright, the borough engineer.

Leeds. A special meeting of the Tramway Sub-Committee of the Corporation has been held for the purpose of considering the tenders sent in for the supply of the plant required for the proposed Roundhay and Kirkstall electrical tramway. Altogether about 70 tenders were received. A couple of firms sent in estimates to do the whole work. All the other tenders, however, were for one or more of the following—viz., poles and brackets, underground conduits and conductors, trolley wires and attachments, electric motorcars, accumulators and switches, steam engines, dynamos, switchboards and accessories, boilers, and for the building of a generating station. When the full Highways Committee met an hour after the sub-committee had been called together, the latter were not in a position to make any definite recommendations, not having been able to go through all the tenders. So varied were the forms in which the estimates were sent in, that it was impossible for the committee to make reliable comparisons at the moment. They therefore instructed the officials to work out the figures on a similar basis, and to have them ready for a special meeting of the Highways Committee. Should it be found an advantage to let the work in sections, the committee have practically agreed as to what firms should supply the steam-engines, dynamos, boilers, and build the generating station. The tenders which the committee regard with favour for these items of the undertaking amount to about £25,000. The whole of the work is likely to cost between £70,000 to £100,000.

Bingley. — The question of providing additional lighting accommodation cropped up at the last meeting of the District Council. One suggestion, brought forward by Mr. Gatecliff was to increase the storage capacity at the gasworks, and the other alternative was the electric light. Just at the moment they might say it was not wanted in Bingley, and some might ask, How could it be obtained? He had been in communication with the directors of the Leeds and Liverpool Canal Company, and they were perfectly willing to erect storage-rooms at the bottom of the Five Rise and the Three Rise locks, coupled together, and were prepared to make and sell electricity to the Council, the latter undertaking the distribution. There were many points they would have to think about in considering this. The directors believed they could produce an equivalent to 20,000,000 cubic feet of gas, and he had found that this was the amount consumed at the mills and railway station and hotels in the town during the year. Therefore, if those places would take the electric light, the increase of the gasworks would be avoided. It might be urged as an objection, that to adopt this proposal would be making a dual ownership in a public matter, and this was a point for consideration. They wanted now an expression of opinion from the large consumers he had named whether they wished to have the light, and if the Council received any encouragement at all the canal company would send an expert to report and give them particulars how the light could be sold and distributed at a profit. He did not think there was any doubt that the canal company could furnish electricity cheaper than the Council could itself, but whether the suggestion was one which it would be wise to adopt was for the Council and the town to consider. He could not tell them the price it could be retailed at per unit, but certainly it would not have to be more than the price in Bradford, or the idea could not be entertained for a moment.

Belfast.—The *Belfast News Letter* describes the electric light station erected by Messrs. George Combe and Co., of Castle-lane-place, Belfast, to supply current to the Empire Theatre of Varieties. The station, which is fireproof throughout, contains two 45 b h.p. gas-engines supplied by Tangyes, Limited, of Birmingham, which are coupled with 8in. double leather dynamo belting to two 500-light dynamos, constructed by the firm of J. H. Holmes and Co., of Newcastle-on-Tyne Either of these pair of engines and dynamos is capable of supplying all the lights required in the theatre. A large battery of secondary cells by the Epstein Company, of London, supply the day load and any such current as may be required after the performance is over at night. They are charged during the hours of performance, thus enabling the engines to be kept at their most efficient load. The station switchboard is made of polished slate, with heavy teak frame, and carries all the measuring and recording instruments, as well as such switches as are necessary for charging and discharging the cells and the supply of current to the large distributing switchboard on the stage The whole installation, including the wiring and fitting of the theatre itself, has been designed and executed by Messrs. Combe and Co. Besides this installation they have now in hand for Messrs. Wm. Barbour and Sons, Limited, Lisburn, a central station for the supply of some 3,000 16-c.p. lamps, requiring about 300 h.p. Mr. George Combe, the senior member of the firm, acts as consulting electrical engineer to the Harbour Board, and has just secured a similar appointment in connection with the hotel which the County Down Railway are putting up at County Down. Mr. Combe also has a similar engagement with the Belfast Ropework Company, Limited, who are going into electric lighting on an extensive scale. The specification for the lighting of Messrs. Dunville's new premises in Arthur-street was also drawn up by Mr. Combe The firm employs a large staff of workmen, under the superintendence of Mr. John Woodside.

Edinburgh.—The second annual meeting of the Association of County Councils in Scotland was held recently, when the following letter was read from the Postmaster-General on the subject of the use of telephones for police purposes at nominal rates: "The question is one that has already been before me, and I have been in communica ion with the County Council for Fifeshire about it. As the general question of the use of telephonic communication by police authorities is raised both in your letter and in that of Mr. Hope, I may perhaps explain that county councils are at liberty, as hitherto, to arrange with the National Telephone Company for the provision, on such terms as may be agreed either at an annual rental or otherwise, of such services as the Telephone Company under their license from the Post Office are empowered to furnish. Broadly speaking, the operations of the company are now confined to certain districts known as exchange areas, but the company are still at liberty to connect police stations either with exchanges by means of 'exchange' wires, or with other police stations by means of special direct wires. The Post Office is also itself in a position to provide direct wires to connect police stations It is only when the trunk wires connecting separate areas, and provided for the use of the general public, have to be used, that the usual trunk fees have to be charged; and the practical question raised in your letter, so far as it concerns my Department, is whether, when these trunk wires have to be used, special terms can be granted for the use of them. It has been explained in a letter to the Fife County Council that the principle which debars this Department from conceding to any person, or body of persons, special terms in regard to the transmission of ordinary telegrams, applies also to communications over the Department's trunk telephone lines; and the decision that the charge should take the shape of a separate payment for each conversation was arrived at by the Government after very careful consideration of all the circumstances. These circumstances have not altered since the decision was arrived at, and, due regard being had to the analogy of postal and telegraphic services, I fear that I can hold out no hope that her Majesty's Government will be able to entertain proposals for a departure from the principle of uniformity of charge to all users. I much regret that I am not in a position to send a favourable reply to the representations of the county councils of Scotland in this matter. At the same time I may perhaps be allowed to observe that, whilst the taking over of the trunk lines of communication by the State may be productive of some inconvenience in a few directions, the public as a whole will undoubtedly benefit largely by the measure." The association decided to memorialise the Government on the matter, and a small committee was appointed to wait on the Postmaster-General and urge a reconsideration of his decision, with the view of being placed on at least as favourable terms as were enjoyed under the Telephone Company.

PROVISIONAL PATENTS, 1896.

JUNE 15.

13145. Improvements in the construction of ammeters and voltmeters. Thomas James Baker, The Municipal Technical School, Suffolk-street, Birmingham.

13151. Improvements in making and duplicating phonographic records. Henry Rheinlander, 15, Albion-grove, Barnsbury, London.

13195. Improvements in or connected with automatic switches for controlling electric lamps. William James Davy, 40, Chancery-lane, London.

13200. Improvements in or applicable to the charging of accumulators. Axel Gottfried Strömberg, 6, Lord-street, Liverpool.

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JUNE 16.

13250. Improvements in telephonic apparatus. Charles Adams-Randall, 93, Chancery-lane, London. (Complete specification.)

13263. A frictional grip for sliding-rods, applicable to holders of electric lamps, carbons, and the like. William Llewellyn Preece, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13264. Improvements in regulating induction electric motors. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Albert H. Armstrong, United States). (Complete specification.)

13267. Improvements in electric switches for street railways and the like. William Ranison Daggett and William Henry Heinz, 18, Buckingham-street, Strand, London. (Complete specification.)

13271. Improvements in electric switches. John Benjamin Verity, 47, Lincoln's-inn-fields, London.

13295. Improvements in or relating to electrically-controlled railway signals. William Phillips Thompson, 6, Lord-street, Liverpool. (Frank McBrien, James Wayland, and James H. Fleming, United States.) (Complete specification.)

13297. Improvements in and relating to electric furnaces. Riccards Pignotti, Ferdinando Lori, Scipione Regnoli, Maffeo Pandaleoni, and Marco Besso, 322, High Holborn, London. (Complete specification.)

JUNE 17.

13339. An improved controlling and feeding mechanism for electric arc lamps. Harold Sisson Jacques, Municipal Offices, Cheltenham.

13405. Improvements in dynamo-electric machines. William Morris Mordey, 46, Lincoln's-inn-fields, London.

13407. Improvements in electrolytic apparatus. Carl Kellner, 46, Lincoln's-inn-fields, London.

JUNE 18.

13449. Improved blasting apparatus for mining and other purposes fired by pressure heat or electricity. Charles Mackintosh, 159, Euston-road, London.

13485. Improvements in telephone switchboards. Isaac Anderson, Robert Wilson Hutchison, and Charlotte Ellen Van Curen, 111, Hatton-garden, London. (Complete specification.)

13488. Improvements in electric incandescent lamps. Godfrey Bamberg, 33, Barcombe-avenue, Streatham-hill, London.

13496. Improvements in incandescent electric lamps. Edgar Julius Sander and Arthur Clifford, 22, Southampton-buildings, Chancery-lane, London.

13520. Improvements in plates for accumulators or secondary batteries. Charles Pollak, 4, South-street, Finsbury, London. (Complete specification.)

13521. Improvements in the manufacture of carbon anodes for electrolytical processes. Peter Jensen, 77, Chancery-lane, London. (Hans Cappelen and Diderik Cappelen, Norway.) (Complete specification.)

13522. Means or apparatus for use in measuring power in alternating-current circuits. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

JUNE 19.

13542. The electric typewriter. Michael McGowan, 163, Great Brunswick-street, Dublin.

13553. A hygienic ear-piece for telephone receivers and such like. Gustav Dubbert, 70, Wellington-street, Glasgow. (Complete specification.)

13604. Improvements in traction engines for towing vessels. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (La Société de Traction electrique sur les voies navigables, France).

JUNE 20.

13644. Improvements in electrical accumulators. Francis William Greengrass and Stanley Reynolds Docking, 70, Chancery-lane, London

13646. Improvements relating to electric accumulators or storage batteries and to the manufacture of plates or electrodes therefor. William Henry Smith and William Willis, 11, Southampton-buildings, Chancery-lane, London

13647. Improvements in mechanical telegraphs for ships and the like purposes. Albert Edward Seaton and William Henry Willatt, 15, St James's-row, Sheffield. (Complete specification.)

13688. Improved electrical apparatus for the treatment of air, gases, and vapours. Auguste Eugène Bonna, Alexandre Le Royer, and Paul van Berchem, 45, Southampton buildings Chancery-lane, London.

13689. Improved electrical apparatus for the treatment of air, gases, and vapours. Auguste Eugène Bonna, Alexandre Le Royer, and Paul van Berchem, 45, Southampton-buildings, Chancery-lane, London.

13691. Improvements in propelling and steering apparatus for vessels. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Société de Traction electrique sur les voies navigables, France.)

13645. Improvements in electric wiring and in apparatus for making connection therewith. Joseph Devonport Finney Andrews, 45, Fulham-park-gardens, London.

13690. Improvements in electrolytic apparatus. Alexandre Le Royer, Auguste Eugène Bonna, and Paul van Berchem, 45, Southampton buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1892.

4248. Arc lamps. Brockie. (Second edition.)

15120.* Electric accumulators. Headland. (Amended specification.)

1895.

10930. Electrolysing chloride solutions. Hermite and others. (Second edition.)

10360. Electric switches. Lancaster.

10418. Time-recording apparatus for consumption of electric currents. Wende.

10647. Electric propulsion of boats, etc. New and Mayne.

12404. Electricity meters. Hookham.

12546. Electricity meters. Chamberlain and Hookham and Holden.

12614. Electric railways. Lorrain. (Esmond.)

15664. Electric railway signals. Siemens Bros. and Co. (Siemens and Halske.)

1896.

4845. Arc lamps. Adams.

6625. Telephone receivers. Fippard.

7854. Regulating electric motors. Otis Elevator Company. (Otis Bros. and Co.)

7885. Incandescent electric lamp bases. Devonshire. (Henry and another.)

8228. Electric generators. Siemens Bros. and Co. and Lauckert.

8483. Joints for electric cables. Siemens Bros. and Co. and Dieselhorst.

8659. Electric accumulators. Schneider.

8660. Electric accumulators. Schneider.

8695. Electrodes for accumulators. Majert.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2	1⅛-1⅜
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	8½-8¾
Chelsea Electricity Company	5	7½-8
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16½-17
—— 5 per cent. Debenture Stock	100	134-138
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	14½-15½
County of London and Brush Provincial Co., Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	10	12½-13½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2¼
Edison and Swan United Ordinary	3	1½-2
—— 4½ per cent. Debentures	100	105-108
Electric Construction, Limited	2	1½-1¾
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	1-1⅛
Elmore's Wire Company	2	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	16½-17½
—— 7 per cent. Preference	10	17-18
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	3⅜-4
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	105-108
Isle of Man Electric Trams, Ordinary	1	1⅜-1⅝
—— 6 per cent. Preference	1	1⅜-1½
Kensington and Knightsbridge Ordinary	5	9-9½
—— 6 per cent. Pref.	5	7½-8
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	17½-17⅝
—— 4 per cent. Mortgage Debentures of £100	100	114½-116½
London Electric Supply	5	1-1⅛
Metropolitan Electric Supply	10	12-14
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7⅝-7⅞
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	9½-9¾
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	11¼-11¾
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary		8-8½
Westminster Electric Supply, Ordinary	5	10-10½
Yorkshire House-to-House	5	7½-8

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